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THE GREAT INDIAN EARTHQUAKE OF 1897.

By CHARLES DAVISON, SC.D., F.G.S.

(*Concluded from page* 150.)

EFFECTS OF THE EARTHQUAKE.

Fissures.—Prominent among the earthquake effects are the fissures formed in alluvial plains. Mr. Oldham estimates that, where the necessary conditions prevail, fissures were fairly frequent over a region which measures about 400 miles from east to west, and about 350 miles from north to south, and present in smaller numbers over one nearly 600 miles in length from east to west. They were naturally more numerous near river-channels and reservoirs, on account of the absence of lateral support, and as a rule were parallel to the edge of the bank, a few hundred yards in length, and varying in width from a few inches to four or five feet.

Fissures in such positions are usually formed during every severe earthquake. But an interesting point established by the Indian earthquake is that they were also found in places far removed from any water-channel or excavation; sometimes running parallel to, and along either side of, a road or embankment; at other times skirting the foot of hills; but in every case clearly due to the compression of the alluvium during the passage of the earth-waves.

Many other evidences of the same compression were observed. Telegraph posts were displaced sometimes as much as ten or fifteen feet. In one part of the Assam-Bengal railway, the whole embankment, including borrow-pits and trees on either side, was shifted laterally through a distance of 6 ft. 9 ins. Rice-fields in Northern Bengal, Lower Assam, etc., which had been carefully levelled so that they might be uniformly flooded, were thrown into gentle undulations, the crests of which were occasionally two or three feet above the hollows. The piers of bridges were moved alongside, as well as towards, the stream. Rails were bent over an unusually large area, the compression caused by the crumpling being always compensated by expansion elsewhere.

Sand-Vents, etc.—"Innumerable jets of water, like fountains playing, spouted up to heights varying from 18 inches to quite 3½ or 4 feet. Wherever this had occurred, the land was afterwards seen to occupy a sandy circle with a depression in its centre. These circles ranged from 2 to 6 and 8 feet in diameter, and were to be seen all over the country." This was at Dhubri, within the epicentral area. At Maimansingh, close to the south of the same area, these miniature craters seem to have been almost equally numerous, fifty-two being counted within an area 100 yards long and about 20 feet wide. In many districts, trunks of trees or lumps of coal and fossil resin were ejected with the water, and even, in one or two cases, pebbles of hard rock weighing as much as half-a-pound.

Over a large area, river-channels, tanks, wells, etc., were filled up, partly by the out-pouring of the sand, but chiefly by the forcing up of the bottoms. That the latter was the more effective cause is proved by the elevation of the central piers of many bridges crossing canals or streams. In this way, channels of from 15 to 20 feet in depth were obliterated, the bottoms being left level with the banks on either side.

Immediately after the earthquake, the surface of many rivers rose from two to ten feet, falling again to the normal level in the course of a few days.

Landslips.—Wherever the conditions were favourable, over an area not less than 300 miles in length, numerous landslips occurred. At Cherrapunji, which is within the epicentral area, there appeared to be more landslip than untouched hillside. Near the same district is a small valley, which, according to Mr. Oldham, was "an indescribable scene of desolation. Everywhere the hillsides facing the valley have been stripped bare from crest to base. . . . At the bottom of the valley was a piled up heap of *débris* and broken trees, while the old stream course had been obliterated, and the stream could be seen flowing over a sandy bed, which must have been raised many feet above the level of the old watercourse."

Rotation of Pillars, etc.—At Chatak, which is close to the epicentral area, is an obelisk, built of broad flat bricks or tiles on a base 12 feet square and originally more than 60 feet high. This was split by the earthquake into four portions. The two upper pieces, about 6 and 9 feet long, were thrown down; while the third, 22 feet long, remains standing, but has been twisted through an angle of 30° with respect to the lowest part, which is unmoved.

Since the great Calabrian earthquake of 1783, this effect of a strong shock has been well known, and very

many examples have been recorded. Its interest lies chiefly in the difficulty of finding a satisfactory explanation, or rather in deciding which of three or four possible explanations is the true one in any particular case. The numerous observations which Mr. Oldham has collected show that, during the Indian earthquake. neighbouring objects similarly placed were generally, but not always, twisted in the same direction; and he adopts the view, at which, however, he arrived independently, that rotation is chiefly due to changes in the direction of the shock. The detached part of the pillar, he believes, is tilted on one edge, and then, before it has ceased to rock, is twisted about that edge by later movements taking place in different directions.

Structure of the Epicentral District.

A large part of the epicentral district is situated in a group of hills lying to the south of the Brahmaputra valley, to which the name of the Assam Range has been given. "It is an elevated tract composed of crystalline gneissic and granitic rocks, with some metamorphic schists and quartzite, which carries a varying thickness of cretaceous and tertiary rocks along its southern edge." Mr. Oldham distinguishes three stages in the history of the range. There was first an old land-surface which, in course of time, was worn down by rain and rivers till they almost ceased to affect its form. Traces of this surface are still visible in the plateau character of the mass. It was then elevated, not uniformly, but along a series of faults, so that it consists now of a succession of ranges, the face of each range being a fault-scarp, and its crest the edge of an adjoining plateau sloping away from the summit. With this elevation began the third and last stage. The streams were able to work again, and deep gorges were carved out of the range, so far that in parts its original character is nearly effaced. But the retention of that character in other districts is of course evidence of the comparatively recent period of the final elevation.

Permanent Changes in the Epicentral Area.

Faults and fractures in the earth's crust are among the most remarkable of these disturbances. They are quite distinct from the fissures which occur in alluvial ground. The former are of deep-seated, the latter of superficial, origin; the one are connected with the causes of the earthquake, the other are merely its effects. The longest of these faults was traced by Mr. Oldham in the Chedrang valley (about 35 miles north-east of Tura) for a distance of twelve miles or more. Running in a nearly straight path from S.S.E. to N.N.W., the fault is crossed about a dozen times by the river, which at these points is either broken into waterfalls or ponded back by the vertical face of the fault. Pools of some extent are also formed by the blocking of the drainage in the western tributary valleys; for, wherever a change of level is perceptible, it is always the rock on the east side of the fault that has been elevated with respect to the other. The throw, or amount of elevation, varies considerably; the highest measured being 35 feet. In two places, it falls as low as zero; and here are formed broad sheets of water chiefly on the eastern side of the fault, and blocked, not by the fault-scarp itself, but by the undulation in the surface of the ground due to the increase of throw further down the valley.

Another fault-scarp, described by Mr. Oldham, is 2½ miles in length, with a maximum throw of 10 feet. There are also fractures along which the throw is either very small or imperceptible. The largest of these is the Bordwar fracture, about fifty miles east of the Chedrang fault. Near Bordwar, it crosses a low hill of gneiss, which it has rent in two. In the immediate neighbourhood of the fracture, the violence of the shock was extreme. Trees were overthrown or killed as they stood, and huge masses of rock were rolled down the slope. When the hill is left, the course of the fracture can be followed for a total length of about seven miles, being marked by landslips or by bands along which trees have been snapped across or overthrown.

While the crust was thus fractured without perceptible change of level, it was, in other places, thrown into long low folds which are apparently independent of faults. These are most easily detected when they cross the beds of rivers and are sufficient to reverse the direction of the drainage. There are then formed small lakes or pools, like the two which occur on the east side of the Chedrang fault. About 15 or 20 miles to the south of this fault, there is a group of such pools, a mile or more in length. The depth of the water increases gradually from both ends, until it reaches from 10 to 18 feet, and here may be seen trees and clumps of bamboos standing in the water and killed by the immersion of their roots.

There are, again, other facts which point to changes of level having taken place over a wide area. From Mao-phlang, near Shillong, a road leads to the neighbouring station of Mairang. Before the earthquake, only a short stretch of this road could be seen, where it rounded a spur at about three miles' distance. Now, a much longer stretch is visible, and it can also be seen passing round the next spur. From a road about five miles from the southern end of the Chedrang fault, it used to be only just possible to see the Brahmaputra over an intervening hill; now, the whole width of the river has come into view. At Tura, which is 95 miles west of Mao-phlang, a battalion of military police were accustomed to signal by heliograph with another station, Rowmari, 15 miles further to the west. This, formerly, could just be done by means of a ray which grazed a hill between the two places; it can now be done quite easily, and, in addition, a broad stretch of the plains east of the Brahmaputra is visible from the same spot. Thus, we see that the permanent changes have taken place over the northern part of the Assam Hills for a distance of about a hundred miles from east to west.

During the cold weather of 1897-1898, a revision of certain triangles was carried out by the Survey, but they were limited to the eastern part of the epicentral area, as the focus was at that time supposed to lie under the Khasi Hills. Of the 16 sides, only one was apparently unaltered in length, two were shortened by an inch or two, while the others were all lengthened by amounts varying from one to eight or nine feet. The heights of most of the stations were also found to be increased, one, close to a conspicuous fault-scarp, by as much as 24 feet. Unfortunately, all of these figures are rendered uncertain by the choice of the stations which form the extremities of the new base-line. One of them lies inside the epicentral area, and the other outside, the line joining them running nearly north and south. But, as compression in this direction is to be expected, it is probable that this line has been shortened, and the assumption that its length was unchanged would therefore lead to an apparent expansion of all the other sides. The only result of the re-survey is thus to place beyond doubt the fact that very important changes of some kind have taken place since the survey was first made in 1860.

Origin of the Earthquake.

The above facts all point to a complex origin of the earthquake. There may have been a number of completely separated foci, giving rise to a group of nearly concurrent shocks. Or, and this is a far more probable supposition, there may have been one great deep-seated focus, from which off-shoots ran up towards the surface.

As Mr. Oldham points out, we have recently become acquainted with a structure exactly corresponding to that which is here inferred. The great thrust-planes, so typically developed in the Scottish Highlands, are only reversed faults which are nearly horizontal instead of being highly inclined; but they are accompanied by a number of ordinary reversed faults running upwards to the surface. In Fig. 2, the main features

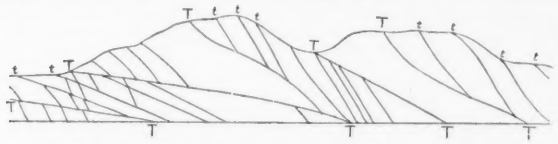

Fig. 2.—Diagram of Thrust-planes and Minor Thrusts.

of a section drawn by the Geological Survey of Scotland are reproduced; *TT* representing thrust-planes, and *tt* minor thrusts or faults. A great movement along one of the main thrust-planes could not occur without corresponding slips along many of the secondary planes. No direct effect of the former might be visible at the surface except in the horizontal displacements that would be rendered manifest by a trigonometrical survey; whereas the latter might or might not reach the surface, giving rise in the one case to fissures and faults, and in the other to local changes of level.

This, it should be remarked, is only a probable explanation. Others might be offered that would account equally well for some of the phenomena, but none, Mr. Oldham thinks, so completely for all the facts observed.

If the main part of the focus were continuous, as this theory would imply, its enormous dimensions will be evident from the facts that have been described. Mr. Oldham has traced the probable form of the epicentre. It may not be quite so simple or symmetrical as is represented by the continuous line in Fig. 1, but there are good reasons for thinking that it does not differ sensibly either in size or form from that laid down. The part of the thrust-plane over which movement took place must therefore have been about 200 miles long, not less than 50 miles wide, and between 6000 and 7000 square miles in area. With regard to its depth, we have no decisive knowledge. It may have been about five miles or less; it can hardly have been much greater.

It is a strain on the imagination to try to picture the displacement of so huge a mass. We may think, if we please, of a layer of rock, three or four miles in thickness and large enough to reach from Dover to Exeter in one direction, and from London to Brighton in the other, not slipping intermittently in different places, but giving way almost instantaneously throughout its whole extent; crushing all before it, both solid rock and earthy ground indifferently; and, whether by the sudden spring of the entire mass or by the jar of its hurtling fragments, shattering the strongest work of human hands as easily as the frailest. Such a blow might well be sensible over half a continent, and give rise to undulations, which, unseen and unfelt, might wend their way round the globe.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., Sc.D., F.R.S.

IV.—THE BEGINNING OF AGRICULTURE.

The origin of agriculture is lost in the mists of antiquity. We know that in Neolithic times in Europe, eight kinds of cereals were cultivated, besides flax, peas, poppies, apples, pears, bullace-plums, etc.; at the same time various animals were domesticated. Among these were horses, short-horned oxen, horned sheep, goats, two breeds of pigs, and dogs. Professor W. Boyd Dawkins says that evidence goes to show that these animals were not domesticated in Europe, but probably in the central plateau of Asia. He also thinks that agriculture arose in the south and east of Europe and spread gradually to the centre, north, and west. However this may have been, the growth of agriculture was in all likelihood slow, and some peoples do not take at all kindly to it.

We have already seen that a hunting population is often very averse to even the slight amount of work that agriculture requires in a tropical country. The same holds good, as a rule, for pastoral communities. In all cases a powerful constraint is necessary to force these peoples into uncongenial employment. Fate is stronger than will, and at various periods, in different climes, hunters and herders have been forced to till the soil.

In the New World there were no domestic animals in pre-Columbian times. Owing to the absence of the horse, the bison that roamed in countless numbers over the prairies could not be herded. On foot the intrepid Redskins tracked and slew with bow and arrow the big cattle they could not tame. When the horse arrived, the Redskins, or Amerinds (as our American colleagues now term them and all other autocthonous tribes), were too inveterate hunters to change their mode of life.

Over a considerable portion of America maize was cultivated from unknown antiquity, and other food plants and cotton were grown in suitable localities. It is doubtful whether the ancient civilizations of Mexico and Peru could have arisen had it not been for the cultivation of maize. Certainly they would have been impossible but for agriculture.

In the West Pacific, again, there are no domestic animals to speak of, no horses, cattle, sheep nor goats; the natives are fishers and hunters who have taken to a simple kind of agriculture, or it might more correctly, perhaps, be termed, horticulture, as no cereals are grown, not even rice, but only root crops such as yams, sweet potatoes, and taro; the banana is the only fruit tree that is cultivated in the true sense of the term, though the cocoanut, areca palm, bread-fruit, and a few other trees are grown. To take one example, the naked savages of Kiwai Island, at the mouth of the Fly River in British New Guinea, cultivate thirty-six varieties of bananas, twenty kinds of yams, and ten sorts of sweet potatoes, all of which have distinct names. Their only domestic animals are the pig and the dingo.

We have seen in the previous article how the deserts of Arabia and Sahara predispose the populations to commerce through the insufficiency of pasturage, and the organisation of the tribe educates the chiefs in the exercise of government.

The passage of these populations to a sedentary life is effected in the oases. These islands of vegetation in the desert are artificial. Created by man they disappear if not maintained by constant care. The creation of an oasis is a particularly difficult enterprise. In this

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burning climate, where rain is scarce, it is necessary to find a place containing a subterranean supply of water before the cultivation of the soil is possible. Thanks to the impermeability of the sub-soil, there are, below the arid wastes, distinct tracts along which water is always procurable. It is first necessary to bring the water to the surface and to direct it to the spots to be watered.

Sahara is not simply a great sea of sand, unsuitable for cultivation. In reality, over large areas the soil is composed of arable land of excellent quality, which solely requires moisture to make it very fruitful. Not only must the water be raised, but the watercourses must be protected against the invasion of the sand, which is a constant menace to agriculture. To undertake such difficult and complicated work, especially by herders who are but little inclined naturally to tedious and protracted labour, these people must have great interest in creating oases.

This interest is not far to seek. The deserts of Arabia and Sahara are not habitable without resting places for re-victualling. They are the countries of hunger and thirst, but in spite of all this man has had a prime interest in travelling through these deserts, for it is beyond them that the richest countries of the world lie—the tropical countries that produce perfumes, ivory, ebony, gold, precious stones, gum, and, above all, spices. It was to reach these fortunate regions that so many maritime expeditions were undertaken in the fifteenth and sixteenth centuries—voyages made famous by Vasco de Gama, Christopher Columbus, and all their glorious lineage of navigators. It was in seeking the country of spices by an eastern route that Vasco de Gama doubled the Cape of Good Hope, and discovered the direct route to Arabia and the Indies. It was in seeking the same country by a western route that Christopher Columbus discovered America. These different tropical products were of a character eminently suited for transport, as they were of great value and of small bulk, and the value was formerly many times greater than it is to-day.

The desert, notwithstanding all difficulties of communication, offered more facilities than the sea to early man; it had, in fact, three manifest advantages over the Mediterranean.

1. The desert penetrates further into the interior of the countries. It is several times larger than the Mediterranean, and therefore can tap more countries; it reaches to precisely those richest countries that the Mediterranean does not touch.

2. The desert does not oblige the pastor to seriously modify his mode of life. In order to traverse the desert it is certainly necessary to arrange the journey in stages, but these stages once created, the pastor can live his old life.

3. A numerous troop can cross the desert. They travel in caravans for greater safety and defence against possible attacks. Contrast this numerous troop with the smaller number who manned the ships of the Phœnicians and other primitive navigators of the Mediterranean, who in those early days had each evening to find a spot sufficiently sheltered to disembark; then they drew their ships ashore, often to find themselves exposed to the attacks of natives. Such are the reasons which caused early man to travel over the desert before voyaging over and utilising the sea. But this crossing of the desert was not possible, and is not possible to-day, without the establishment of resting places. Who could undertake the establishment of oases in a society of herders divided up into autonomous and often inimical tribes?

One can reply without hesitation. It was a group of men who, in the present and as far back in the past as records go, appeared always as the unique, uncontested, and omnipotent dominator and civilizer of the desert. This group does not belong to one tribe in particular, but it counts fanatical adherents among all tribes from one end of the desert to the other. It is the group that all conquerors who have tried to penetrate into the desert have found before them; the English as well as the French. These rulers of the desert are the religious fraternities or zanias; the members are called khuans, "brothers"; their chiefs khalifs, sheiks, etc. Sometimes, at certain epochs of inspiration or greater religious fervour, they are called Mahdi, "the well-guided." At these times woe betide those who attempt to penetrate into the desert. As the only point of contact between the different tribes was the community of the religious sentiment which is so highly developed among pastoral peoples, it was naturally the religious sentiment which became the shield and protection of the traders in the midst of hostile tribes. As the profits of commerce brought considerable benefits, these brotherly protectors of trade developed extremely rapidly and accumulated enormous riches. None can safely traverse the desert without placing themselves under their protection.

One can better understand this influence if one remembers that in the Middle Ages commerce found a safeguard, support, and an auxiliary in the military religious orders, a fact due to the influence of analogous causes. Then, as in the desert, there was no central government, only a multiplicity of petty rulers with limited authority, who could not give general protection to commerce. The military religious orders naturally hastened to take up the *rôle* of protectors of commerce. One knows that the Templars, for example, practised it themselves, that they were the great bankers of that time, and that they thus acquired immense riches. And they declined precisely when the great political governments developed in the west and became able to protect commerce from afar. But the desert being by its nature unchangeable, the religious brotherhoods continue to this day.

The oases serve the double object of places for re-victualling and *depôts* for merchandise. To re-victual caravans and also to feed its inhabitants it is necessary to draw from the soil the greatest amount of food within the restricted areas. The only vegetable that accommodates itself completely to the special conditions of soil and climate is the date palm. Its fruit is truly the bread of the desert; with camel's milk it forms the staple food. Dates present great advantages to desert travellers. They are easy to preserve by desiccation and easy to carry, as pressed into bags they contain a large amount of nourishment in a small bulk. Each tree furnishes about 26 lbs. of dates in a year.

But the palms yield other products; the crushed date stones supply food for goats and even camels; the fibre, leaves, and trunk, are all utilized for various purposes. Thanks to the grateful shade they spread, the effects of the tropical heat and burning sun are lessened. There is cultivated under their shade a number of plants which very usefully supplement the direct gifts of the palm. Thus the oases produce beans, cabbages, carrots, melons, tomatoes, egg-plants, apricots, peaches, apples, quinces, etc. Plants that require heat

and light with us demand the coolness and shade that the palm tree affords.

The oases are the *depôts* of merchandise, and are the chief market centres of the desert, whose riches naturally excite envy and must be protected: thus the oases are fortified.

The oasis modifies the social organization in three essential matters:—

1. Work becomes sedentary, but trade and commerce predominate over agriculture. The complication due to a fixed home is reduced to a minimum, for the men of the oases continue to live a nomadic life for at least part of the year. It is these men who effect transport and who trade either for themselves or others. Besides, the actual cultivation of the oases is relatively easy, it is almost spontaneous, as the chief products are from palm and fruit trees; it is arboriculture, which is the easiest of all. The growing of vegetables does not need any great foresight, for the period of growth is so short; the work they need is soon repaid by the product. Further, the men mainly avoid doing this work. It is relegated to women and to negro slaves, who also form an important article of commerce. Thus this cultivation has not the result of reducing the men to work hard at husbandry. Count Goblet d'Alviella writes:—"Every year a certain number of Suafos emigrate into the towns of Tunis and Tell, where they live in the Moors' quarters as blacksmiths, masons, clerks, etc.; but, like the Swiss and Savoyards, they have a great attachment to their native land, and nearly always return thither when their fortunes are made. They then marry several wives, whom they employ to weave. They buy negroes, and thus realise, in pious idleness, the Musulman's ideal life."

2. The condition of women is raised. She has the sole charge of the workshop during the long absence of her husband; she watches over the gardens and flocks, which feed around the oasis, and she makes various domestic fabrics. She thus acquires a position of mistress of the house, and is as much, and often more than the husband, the source of income to the household.

3. Government is constituted outside the community of the family. How could government be constituted outside the family in the societies which we have seen are so strictly limited to the family and the tribe which is, after all, only an enlarged family?

Who could organise government except the religious brotherhoods who have created the oases? The administration of the oases is in the hands of the khuans and zanias, who reign as masters. In the larger oases all the religious orders are represented, their wealth is enormous, but their organisation is very simple. The members of the order are composed of khuans ("brothers") and mokaddems and sheiks. The khuans are the mass of the initiates. By mokaddem is meant the direct representative of the sheik, who receives alms, presides over religious ceremonies, and directs the consciences of the khuans. The sheik is the supérieur général or grand master of the order. He resides in or near the tomb of the holy founder of their order, and gives the baraka or benediction. Often below the initiated khuans there are khoddams, servants or clients, who do not receive the special prayer of the order. They are generally entire tribes who adopt the policy of the order and act as defenders. The fraternities hold in their hands the administration of the oasis. This is summed up in the djemâa assembly of notables, chosen by each of the quarters of the oasis from the ranks of the khuans.

Dependent upon the djemâa are six functionaries chosen from the dominant religious party. One is a sort of police agent; he guards the gates, signals the approach of an enemy by beating a drum, is the chief of scouts, and receives travellers and appoints them to various houses. The second unites the functions of the public crier and the clerk of the works. The third is the distributor of water—a very important trust. These three are paid in kind. The three following officials hold purely religious posts. The steward of the mosque is an honorary appointment. The marabout, who has charge of the services, recites the daily prayers, presides at all ceremonies and funerals, and teaches in the school, is lodged and paid. Finally, the muddin, five times a day mounts the minaret of the mosque to cry the prayer of Islam.

Naturally these brotherhoods quarrel for supremacy, often long and cruel wars result. At the present time one of these orders is pre-eminent, it is the famous order of Snussia. The Snussias cleverly tried to constitute a vast federation of all the religious orders, to create a theocratic panislamism, exclusive of all secular authority. To render this federation more acceptable they have reduced to a minimum their religious formulas and the duties imposed on the khuans. This order is recent, being founded about 1835, by Si-Mohammed-ben-Ali-ben-Snussi. After many vicissitudes he founded a zania at Djerboub, in Tripoli, and since then more than 250 in Sahara and Arabia; all are directed from Djerboub, the headquarters of the order.

On the northern borders of the Sahara are more or less cultivated lands, which are termed by Demolins "half oases," who states they are largely peopled by fugitives from the desert—that is, by people who, in every epoch, have been evicted from it; speaking generally, they have not gone of their own accord, for these men, little accustomed to work, prefer the adventurous life of the desert to the narrow life of its confines. They bring with them, however, their aptitude for business and their skill in organising government, which become still more accentuated under the new conditions. These border countries are often not favourable to agriculture. Many are mountainous and have poor soil; but they are favourable for barter, lying as they do between two great commercial highways, the sea and the desert. The inhabitants therefore take to commerce. In these border states agriculture is undertaken by the least capable and enterprising; the others give up agriculture on the first opportunity and take to small manufactures or to commerce.

The various Kabyle tribes have each their speciality, and as they hold markets in each village on successive days the inhabitants can procure all they require. Many women make beautiful pots. Weaving occupies some tribes, wood-carving others, some are clever blacksmiths. One has learned from a French deserter how to make guns. Jewellery and smelting constitute the industry of one group. Their markets are busy, and are used also as general assemblies for the discussion of public business. The emigrants from the villages carry on different trades. Some become bakers, others bankers to their fellow countrymen in the different villages, most become pedlars. They are in no great hurry to accomplish the pilgrimage to Mecca, and when they do go, they travel more as merchants than as pilgrims.

Here on the border countries the influence of the

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religious brotherhoods persists, but the organisation of government is freer and more spontaneous. There is less need to submit so completely to the interference of the brotherhoods. The chiefs of the families are apt to set going the machinery of political life by themselves, and they emancipate themselves from the tutorship of the religious orders. Thus the authority of purely religious powers tends to diminish while that of the family chiefs increases. Reclus states:—"They respect the marabouts; at the same time they are suspicious of them, and take care not to let them infringe on the rights of the community. They assign to them special villages situated apart from the tribal villages, and therefore liberty is not likely to be endangered." What a change for these men who opened up and organised the desert and who still govern it!

Each village forms "a small republic governing itself." All the citizens form part of it; as soon as they carry arms they have the right of voting. The Djemâa meets once a week and decides all questions. One can therefore say that in the desert borders power passes from the religious to the lay form of government; but in its new form this power continues to follow the same tendency that invariably inspires the communitary formation, which encroaches upon and in its very nature tends to restrain the initiative of the individual in private life. But here the state increases, since, owing to the sedentary mode of life, the community of the family is both restricted and enfeebled and opposes a decreasing resistance to the action of an external government.

In my next article I propose to deal with other communities having a similar origin from pastoral peoples who have also been constrained to till the soil.

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

VII.—METEORS;—THE PERSEIDS.

OF all the subjects for study open to the astronomer who has no optical assistance at his command, none can be so easily or so frequently observed, none afford him such an opportunity for really useful work, as do meteors. And though meteors may be observed practically the whole year round, except when cloud or moonlight interferes, yet one month ranks pre-eminently as the meteor month—the month of August.

This is due to the occurrence then of the well-known periodic shower of the Perseids; the "Tears of St. Lawrence."

It is very striking in looking back into astronomical records to note how very recent is most of our information concerning meteors. For thousands of years men have been aware that there were "wandering stars to whom was reserved the blackness of darkness for ever." At times, too, they would come, "not single spies but in battalions," in such numbers and with such brightness as to compel attention and create the deepest astonishment and fear. But for all those ages it does not seem to have occurred to anyone to try and *observe* them; that is to say, to record such facts about them as it was possible to ascertain during the brief moments that they shone.

There is an immense gulf between the mere admiration of the phenomena of nature and their observation. The first is utterly unfruitful; long generations of men pass, each having seen the same kind of event, and yet the accumulated experience of ages leads to nothing. But, on the other hand, let one man, or, better, let three or four give a few years to the careful, steady record of everything that they can ascertain about some phenomenon, however unpromising, and what marvellous facts leap into light!

How utterly ignorant even recognized authorities were but sixty years ago may be seen from the following quotation from a standard text-book bearing the date 1840.

> "The Falling Stars, and other fiery meteors, which are frequently seen at a considerable height in the atmosphere, and which have received different names according to the variety of their figure and size, arise from the fermentation of the effluvia of acid and alkaline bodies, which float in the atmosphere. When the more subtile parts of the effluvia are burnt away, the viscous and earthy parts became too heavy for the air to support, and by their gravity fall to the earth.
>
> "On the 13th of November, in the year 1833, a shower of meteors fell between lon. 61° in the Atlantic Ocean, and lon. 100° in Central Mexico, and from the North American Lakes to the southern side of Jamaica. These fireballs were of enormous size; one appeared larger than the full moon at rising. They all seemed to emanate from the same point, and were not accompanied by any particular sound. It was not found that any substance reached the ground so as to leave a residuum from the meteors."

It did not seem to occur to the writer of the above description that the circumstance which he mentions—namely, that the meteors "all seemed to emanate from the same point," itself proved that the meteors were entering the atmosphere from outside and were moving along parallel lines at the time of their entry.

The great display referred to above, however, was the foundation of modern meteoric astronomy. So magnificent a spectacle as was then witnessed not only attracted thousands of gazers, it caught the attention of men who were resolved to use every possible opportunity for learning.

The enormous numbers of meteors seen in the November shower of 1833 rendered it manifest that on that occasion, at any rate, the falling stars seemed to have their origin in a single point of the heavens, and therefore it became an important point whenever a meteor was seen to note exactly the direction of its flight. Humboldt, who had himself seen the great November shower of 1799, writing in 1844, recognized four points in the heavens from which meteors seemed to fall, and drew attention, though with some hesitation, to the reasons for thinking that the November shower was only occasionally to be seen in great force. Sir John Herschel, about the same time, recognised only two showers, those of August (the Perseids) and those of November (the Leonids). Now by the labours of a very few observers, one of whom, Mr. Denning, may be said to have outweighed all others put together in the value and number of his results, we know of many hundreds of radiant points, whilst the researches of Adams and Schiaparelli have enabled us in some cases to trace the meteor streams in their path, not only far beyond the spread of our own atmosphere but to the very limits of the solar system, and they have been shown to be not mere distempers of the air, but bodies of a truly planetary nature, travelling round the sun in orbits as defined as that of the earth itself.

How has this great advance been made? Simply by careful, patient, intelligent, observation. First of all by carefully noting the points in the sky where the meteor was first seen and where it disappeared. This requires a thorough knowledge of the constellations, as indeed all naked eye astronomy does, and great quickness of observation. The meteor worker must be able

to give the two extremities of the path at a glance and to remember them faithfully until he can in some way or other note them down.

For this he will require a certain amount of what we may term apparatus, either a celestial globe or a set of star charts. The choice of the latter is of importance, as no possible chart can show the entire sky without grave distortion some way or other, and more important for the present purpose there is only one projection which will give a straight line on the chart for all great circles or parts of them; that is to say, for all lines which impress us as straight lines as we see them on the sky.

The observer's first duty, therefore, is to acquaint himself with the constellations; his next, by repeated and persistent effort, to learn quickness and correctness in fixing the extreme points of the meteor paths. This done, he will recognise that there are several other features in which meteors appear to differ, the one from the other. His observations of the paths will soon show him that the length of a meteor path varies greatly; he cannot fail further to notice that the apparent speed with which it travels varies also. To the record of the path, therefore, should be added the determination of its length, which of course can be read off from the globe after the track has been marked down upon it, and the time which the meteor took to traverse it. And as for comparison with the records of other observers it is essential to know when the meteor was seen, this should also be noted as well as the duration. Indeed, as a matter of order, the date and time of the occurrence should come first; then the position of the beginning of the path; third, the position of the end; fourth and fifth, the length of the path and the time which the meteor took to traverse it.

The actual meteors themselves also have their individual characteristics. Some leave phosphorescent streaks behind them, others trains of sparks. More striking than anything else is the enormous difference in brightness, from one like the meteor alluded to above "larger than the full moon at rising," down to others only just visible to the naked eye. These particulars as to character and brightness will be the sixth and seventh items to note, and when a number have been observed sufficient to give an indication of the radiant, this should be added as an eighth.

Steady persistent practice in noting these particulars will soon give the observer increased skill. One item requires especial attention—the duration of the meteor. Mr. Denning tells us that he has trained himself by observing the flight of arrows. He has employed a friend to shoot these to distances from fifty to two hundred yards at right angles to the line of sight, the elevation being varied as much as possible, and that by repeating these experiments he has learned to judge intervals of from one to five seconds with an average error of less than one-fifth second.

All the above particulars and not merely the direction of the paths alone are of value in the determination of the radiant point. The meteors of one radiant have similar characters as to colour, streaks, etc., and also as to speed of course. The apparent length of path is affected by the height of the radiant point, Mr. Denning noting of the Perseids of August 10 that, whilst between 9 and 10 o'clock in the evening the brighter meteors average a course of about 30°, in the morning hours when the radiant is near the meridian their paths are only one-third the length.

As in all good work, skill is not acquired at once, and the would-be meteor observer will find that he makes many failures to begin with. His first successes will probably be with some bright slow-moving meteor, and as these are relatively few, he will probably have to wait a very considerable time before he can accomplish much. This need of patience and practice is one great reason no doubt why so few take up a pursuit which requires no equipment and which soon becomes full of fascination. Another is to be found in the unfortunate fact that from midnight to dawn is a much more fruitful time than from sunset to midnight, since the meteors which come to meet the earth are necessarily much more numerous than those that overtake it, and the earth has its sunrise point in front as it moves forward in its orbit, its sunset point behind.

Yet there are always prizes to be secured. There is a great pleasure when some brilliant wanderer flashes by in knowing that one has secured as full and accurate a record as possible of its appearance. It was seen but for a moment,

> "Like a snowflake on the river,
> One moment white, then gone for ever."

Yet it has left something behind, something permanent, something which years after may be eloquent of unsuspected truth.

The great Perseid shower, chief of all those which are of regular annual recurrence, has been rich in such indication. It has shown itself to be in intimate connection with the Third Comet of 1862 discovered by Swift. It has been traced night after night for a very considerable time before the date of its maximum, August 10, the radiant point travelling steadily backward in the sky from the borders of Cassiopeia and Andromeda in the middle of July to those of Camelopardus in the middle of August; the steady shift of the radiant, night after night, having been abundantly demonstrated by observations as well as being in strict accordance with theory.

In sharp contrast with the shifting of the Perseid radiant has been another fact which long years of patient work has enabled Mr. Denning to demonstrate—namely, the existence of radiants which do not shift, radiants which endure for many months together. Here was a circumstance which could not have been anticipated, which was indeed in flagrant contradiction to the theory of meteoric motion, and which even yet remains without any adequate explanation. Yet one single observer, by sheer patience and perseverance, has driven home the unexpected, unexplained, seemingly impossible fact, and after having been long rejected even by experts, the fact of stationary radiants has at length received general recognition.

Such a fact, unexampled in the history of astronomy, ought to make many a meteor hunter. For six thousand years men stared at meteors and learnt nothing, for sixty years they have studied them and learnt much, and half of what we know has been taught us in half that time by the efforts of a single observer.

[The illustration on page 158 (July) should have been lettered "The Milky Way in Cygnus; from M. C. Easton's 'La Voie Lactée.'"]

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28

(Second Paper.)

By E. WALTER MAUNDER, F.R.A.S.

THE Eclipse of 1900 has been so very prolific of result that, even at this early date, to adequately notice everything that has come to hand would require a long series

of articles. I propose, therefore, on the present occasion simply to catalogue the results which seem to me to be of most importance.

1. LARGE SCALE PHOTOGRAPHS.—By large scale photographs I mean photographs giving a diameter of four inches or more to the moon's disc. These are becoming more and more a regular feature of eclipse work, and on the present occasion both the Astronomer-Royal and the Astronomer-Royal for Scotland from this country undertook this department with great success. The instruments were of very different types. The Astronomer-Royal's camera possessed an object glass of 9 inches aperture and only 8½ feet focal length, a four inch image being obtained by a negative combination within the primary focus; the camera was fixed and fed by a cœlostat. Dr. Copeland's instrument was the 40 foot focus lens which he took to Norway and to India. This was not pointed direct to the sun, as at Vadsö in 1896, but the light was reflected into it by a fixed mirror, and the plate was made to travel instead of the telescope. This ample scale has been exceeded by the American astronomers, who have used object glasses of 61½ and 133 feet focus, securing photographs on scales of seven and fifteen inches to the lunar disc.

Without dwelling at length upon the beautiful detail both of corona and prominences shown on the Astronomer-Royal's photographs, a comparison of his Indian and Portuguese negatives teaches a very significant lesson. Valuable as each series is in itself, it is not too much to say that each has a double value in its comparison with the other. It is most earnestly to be hoped that no slight difficulty will be allowed to prevent a series so magnificently begun being continued, eclipse after eclipse, with the same instrument and on the same scale. The closing in towards the equator of the great extensions, the diminution of structure in the lower corona, the greater separation of the polar plumes, and the greater amount of general diffused, amorphous coronal light, as seen in the Eclipse of 1900 when compared with that of 1898, is most evident. This year's

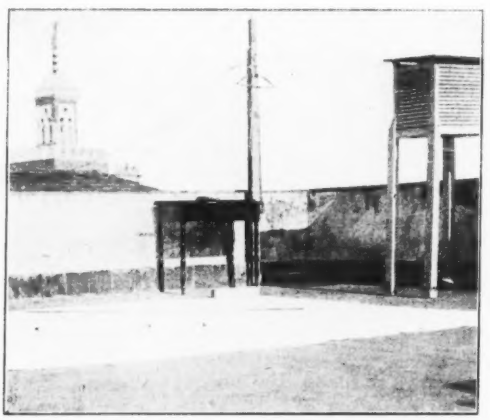

FIG. 1.—The Meteorological Instruments and Shadow-Band Sheet, Hotel de la Régence, Algiers.

From a Photo by Miss EDITH MAUNDER.

eclipse was emphatically an eclipse of the sun-spot minimum; it reproduced the general form,—it is scarcely an exaggeration to say, even the detail,—of the Eclipses of 1878 and 1889, at the two preceding minima with astonishing fidelity.

2. MEDIUM SCALE PHOTOGRAPHS; that is to say, of a scale of half-an-inch to two inches. These were too numerous to catalogue, but here we must express a regret. For a long series of years the British official expeditions have taken photographs with identical lenses of about 5 feet focus. It is a pity that the series has this year been brought to a close or at least interrupted.

3. SMALL SCALE PHOTOGRAPHS; that is to say, less than half-an-inch in diameter. A large number of these were no doubt taken with fixed cameras in consequence of our having pointed out that for most purposes there was no need to use a driving clock with short focus lenses. But several were taken directly in consequence of the success in their delineation of the coronal extensions of our long exposure photographs in India. The result of these so far as we have yet heard has been to show distinctly that it was not possible *in this eclipse* to photograph the streamers to the same extent as in 1898, but, on the other hand, quite a short exposure proved practically as effective as the most lengthy given, in bringing them up. Still the character of the extensions was the same; the typical coronal curves running as in 1898 into rod-like rays.

Before leaving the photographs of the corona, it may be worth while to mention a mistake into which apparently more than one photographer has fallen, that of driving on the moon instead of on the sun. A stationary camera will give a blurring of 15″ of arc for an exposure of one second of time; one made to follow the moon gives a blurring of ½″ in arc for an exposure of the same time, and *vice versa* if it follows the sun, the blurring of the moon's limb in the direction of motion will be of the same amount in the maximum. An exposure therefore of ¾ of a minute would mean a blurring of considerably more than a third of a minute of arc. This would mean 1/100 inch for an inch sun, or a millimetre for one of 4 inches. These are very considerable amounts, hence a long exposure photograph cannot be given so as to ensure sharpness both of moon and of corona. A sharp moon under such circumstances means a blurred corona.

4. INTEGRATING PHOTOGRAPHS.—Several Members of the British Astronomical Association, myself amongst the number, devised a method for exposing photographic plates to the general light of the corona in 1896. The unfortunate weather on that occasion prevented the scheme being carried out, but Mr. Gare and Mr. A. H. Johnston arranged a careful scheme in 1898, the execution of which was successfully carried out by Mr. E. W. Johnson. The same observers repeated their experiments at Manzanares and Elche in Spain this year, and they have had a follower in Professor H. H. Turner, who carried out a similar work at Algiers. Professor Turner's result shows this eclipse to have been very considerably brighter than the Indian; Mr. Gare finding the corona seven times as bright as the moon in 1898, Professor Turner putting it at ten times the moon in 1900.

5. STANDARDIZED PHOTOGRAPHS.—Most, if not all of the photographs of the corona obtained by the British official observers have been "standardized" by the imprinting upon the plates of a series of squares representing known light values. This practice gives to the photographs an entirely new importance over and above the value they possess as pictures, and it is much to be wished that the practice were more general with independent observers. The work of measuring and reducing the photographs of the late eclipse can scarcely have proceeded very far as yet, and no results in this line have yet appeared from them; but similar results from

the 1898 Eclipse, now two years and a half old, should by this time be in a very complete state of discussion. It is much to be regretted that a little more speed was not made so that they might have been in the hands of astronomers before their starting for the late eclipse.

6. POLARISCOPIC PHOTOGRAPHS.—To Professor Turner in 1898 we owe the revival, as an item of eclipse programmes, of the taking of polariscopic photographs of the corona, most successfully carried out by, and under the direction of, Professor A. W. Wright in 1878. This work Professor Turner, in conjunction with Mr. Newall, renewed in the late eclipse, and it is to be hoped the success they attained will prevent it being again dropped, for it is to be borne in mind that at present we have only polariscopic photographs from minimum coronæ, and it is a matter of great importance to ascertain whether the intensity and distribution of the polarization vary at different parts of the sun-spot cycle.

7. SPECTROSCOPIC OBSERVATIONS.—Photographs of the spectrum formed a most important feature of the programme of all the official parties. Mr. Dyson at Ovar had two large slit spectroscopes; Sir Norman Lockyer at Santa Pola had a prismatic camera of 20 feet focus; Dr. Copeland used a prism in front of his lens of 40 feet focus during part of the eclipse; Mr. Newall at Bou Zaréa photographed the "flash" with a slit spectroscope; Mr. Evershed at Mazafram, as recently mentioned, had two prismatic cameras, one of them being a reflector. All appear to have been most successful in their work, but many months will necessarily elapse before the photographs obtained will be measured, reduced, and published. It may be mentioned, however, that Mr. Evershed's reflector photographs give the lines with unexampled sharpness of definition from end to end, and that Dr. Copeland claims to have secured the spectrum in the ultra-violet so far as wave-length 3000.

Amongst the independent observers it should be mentioned that Dr. Downing, observing with an opera-glass fitted by Mr. Thorp with a prismatic grating before the object glass, found the combination work most admirably. The special subject of his scrutiny was the diffusion of "coronium" as evidenced by the shape of the green coronal ring. This averaged about 100,000 miles in height, but in one particular region it rose to a height of 180,000.

8. SHADOW-BAND OBSERVATIONS.—These appear to have been made with special fulness and care at several different stations. The results of these observations have not yet been collected, but it may be mentioned that Mrs. Arthur Brook, whose apparatus is shown in the photograph, observing at Algiers noted the "bands" rather as separate patches closely following each other in long wavering ranks. Mrs. Brook made observations of a unique character on the "shadows" near the time of third contact when Baily's Beads began to appear, and she asserts that the "shadow patches" were then of a materially different character from what they were a few seconds later still, when the sun itself emerged and the light was stronger. As in India there is a marked divergence of opinion at different stations as to their directions of motion before and after totality. At Algiers Mr. Brook says decidedly that the direction before second contact was approximately the same as after third contact. At Elche the observers say that the second direction of motion was reversed.

9. NAKED EYE DRAWINGS OF THE CORONA.—Of these the late eclipse has yielded an unprecedentedly large supply, of the average quality of which it is scarcely possible to speak too highly. It is a curious and unexpected detail of evolution that not only is there a progress in artistic ability and truth in the individual through the means of his personal practice, but there is also in the race. The same sort of thing has been noticed before now in drawings of the surfaces of the moon and planets. Men see more easily and depict more faithfully, faint, difficult or minute markings, than was done fifty or a hundred years ago. Indeed the trend towards uniformity has been so strong as occasionally to draw forth sharp criticism, and hints of the effect of bias. That could not be the case here; drawings made by observers separated from each other by scores or hundreds of miles and having not the slightest means of communicating with each other have by their resemblance borne the most striking testimony to the skill

FIG. 2.—The Harbour, Algiers, five minutes before Totality.
From a Photo by MISS EDITH MAUNDER.

and fidelity of the artists. There has been a complete absence of the grotesque and extravagant designs that were common enough a generation ago. Some of the drawings too were made with the most astonishing rapidity, Miss Stevens', for example, already reproduced, was the result of less than forty seconds devoted to the scrutiny of the corona, and yet,—though not intended to exhibit in particularity the details of the corona,—it could be scarcely surpassed as a representation of the general effect. This improvement is a matter for the greater congratulation since it is manifestly due to greater skill in the observer, and the observer must always be more important than the instrument. The improvement in the delineation of planetary surfaces might well have been ascribed to the improvement of telescopes, but that cause cannot enter in the case of drawings of the corona made with the naked eye.

10. DRAWINGS WITH THE TELESCOPE.—This work has been to a very great extent the special feature of the late eclipse. In particular it is a subject for congratulation that Mr. Wesley, whose skill as an artist is so well known, and whose acquaintanceship with coronal forms as shown on photographs is unapproached, was by the most generous courtesy of M. Trépied put in possession of the equatorial coudé of the Algiers Observatory on the occasion of the eclipse. "I think," said Mr. Wesley, "I have had the most magnificent—though restricted—view of the corona that ever mortal man had—something to have lived for." Mr. Wesley made a study of and sketched the entire corona within his field of view, which

did not of course include the outer streamers. His first impression was that of the entire familiarity of the object he beheld; the photographs of 1878 and 1889 had so exactly presented the same leading features. The great difference was that in looking at the reality and not at the photographic picture a sense of perspective and of relief was perceived, whereas the photographs seemed essentially plane sections. In one sense the sight was disappointing; there was no structure seen more detailed than the microscopic scrutiny of photographs had already made Mr. Wesley familiar with. Probably no one else knows how much the photographs really have to show. However both the photographs and direct examination concur that the corona at this eclipse showed much less structure than in 1898 and other years nearer the solar maximum.

One form in particular Mr. Wesley looked for. Round the more brilliant prominences of 1893, the corona was perceptibly fainter for some little distance; a brighter margin including the prominence region some way further out. The prominences therefore seemed to be arched over by bright coronal matter, giving somewhat the effect as if they were under glass cases. Mr. Wesley could not, however, recognize this "glass case" appearance, nor do the photographs clearly show it.

This last conclusion is more than confirmed by the detailed examination made by Miss Lilian Martin-Leake with a three inch telescope mounted on the roof of the Hotel de la Régence, Algiers. Miss Martin-Leake used a higher power than Mr. Wesley, and hence had a smaller field of view, only commanding a part of the corona but giving this with more detail. The portion of the limb examined by Miss Martin-Leake, whose drawing is reproduced in the plate, had for its centre the great prominence in the south-west quadrant. It will be seen from the drawing that the chief coronal streamer in the region under examination had its polar edge very sharply defined;—nothing further to the south, of a coronal character, could be perceived within the field of view; a circumstance to which we shall have to allude again a little later.

Round the great prominence itself there was an approximation, indeed, to the "glass case" effect, but with a difference. Instead of inclosing the prominence, two of the "glass cases" appeared to start from between the two wings of the prominence. The taller of these wings was a conical flame, red in colour, proceeding straight upwards from the limb, tapering to a fine point at its apex and showing strongly defined spiral markings throughout the whole of its upward course. The other part of the prominence consisted of a thick radial stem also with strongly defined spiral markings, but about three quarters of the height of the taller prominence from the limb, the second one bent sharply, almost at right angles, towards it.

The same region was also examined in the telescope, but only for a few seconds, by Mr. Crommelin, who drew three conical projections corresponding most closely to those brighter portions of the corona inclosed within the outlines which Miss Martin-Leake has shown.

11. DARK RAYS IN THE CORONA.—I may be forgiven for again reverting here to the fact that my wife and I had but a very small instrumental equipment both in the eclipse of 1898 and in that of 1900. We felt therefore that it would be quite absurd for us to attempt to do on a microscopic scale what was being done by others in an infinitely more satisfactory manner, namely, to get a photographic picture of the corona. If our work was to have any value at all it must be something different from that which others were doing far more efficiently than we could hope to do. In India, therefore, we set ourselves a two-fold task; the first to give a series of exposures to the corona varying over a far wider range than any that had been attempted before; the next to get, if possible, a photograph of the faint outer streamers of the corona. Both attempts were successful, but inasmuch as our longest Indian exposures were the most successful in bringing up the rays, it left it an open question whether a still further prolongation of the exposure might not record those rays to a still greater distance from the sun. In the eclipse just past, therefore, we prolonged our exposures to the utmost extent which the circumstances of the eclipse permitted, with the result of finding that for this eclipse, at any rate, increase of exposure did not mean increase of extension.

But these little long-exposure photographs of ours do show features which are not shown, or, at any rate, not shown so distinctly on our photographs of shorter exposure. Of deliberate purpose we pushed exposure and development to the furthest limit that the circumstances of the case allowed. Our object was not to get a photographic picture of the corona; we knew that was being far better done elsewhere. Had we been trying for such, then both our exposure and development would have to be censured as extravagant. As it was, we obtained a most unexpected result that could probably have not been obtained in any other way.

It will have struck anyone who has examined eclipse negatives that upon these the moon very frequently comes out much darker than the sky even at a great distance from the sun. This is a very remarkable circumstance, for we must remember that in an eclipse the moon is more fully illuminated by "earth-shine" than on other occasions. The moon therefore is not black or anything like it in a total eclipse, and if it appears much darker than the sky, it can only be because there is a very appreciable amount of diffused light round the sun itself perfectly distinct from any scattering in our own atmosphere.

This consideration gives its significance to a very curious feature of our little photographs, namely, some *black rays;* rays, that is to say, distinctly darker than the general sky background, or rather what I may call the general coronal glare. The largest and darkest of these rays, it may be added, is that shown on the edge of Miss Martin-Leake's drawing as a region free from coronal light.

These dark rays are not a mere contrast effect, for though undoubtedly the northern edge of the principal one corresponds to the southern edge of the great south-western streamer, yet it is traced as a distinct black line further than the bright coronal ray on the border of which it lies, nor is there any very manifest bright ray to define the other, that is to say, the southern side of the dark ray. These dark rays therefore can only be seen as such where the exposure and development have been sufficient to bring up the general coronal glare.

The matter is one of great importance as it regards our conception of coronal structure. The explanation of the great rifts which have often caught attention both in the corona itself when observed directly and in photographs of it, has been extremely difficult, on the assumption that they are the mere interspaces between the bright streamers, since it is inconceivable that the corona is really what it appears to be, an object in two dimensions only. I think our photographs, though on so small a scale, afford evidence that in some cases at

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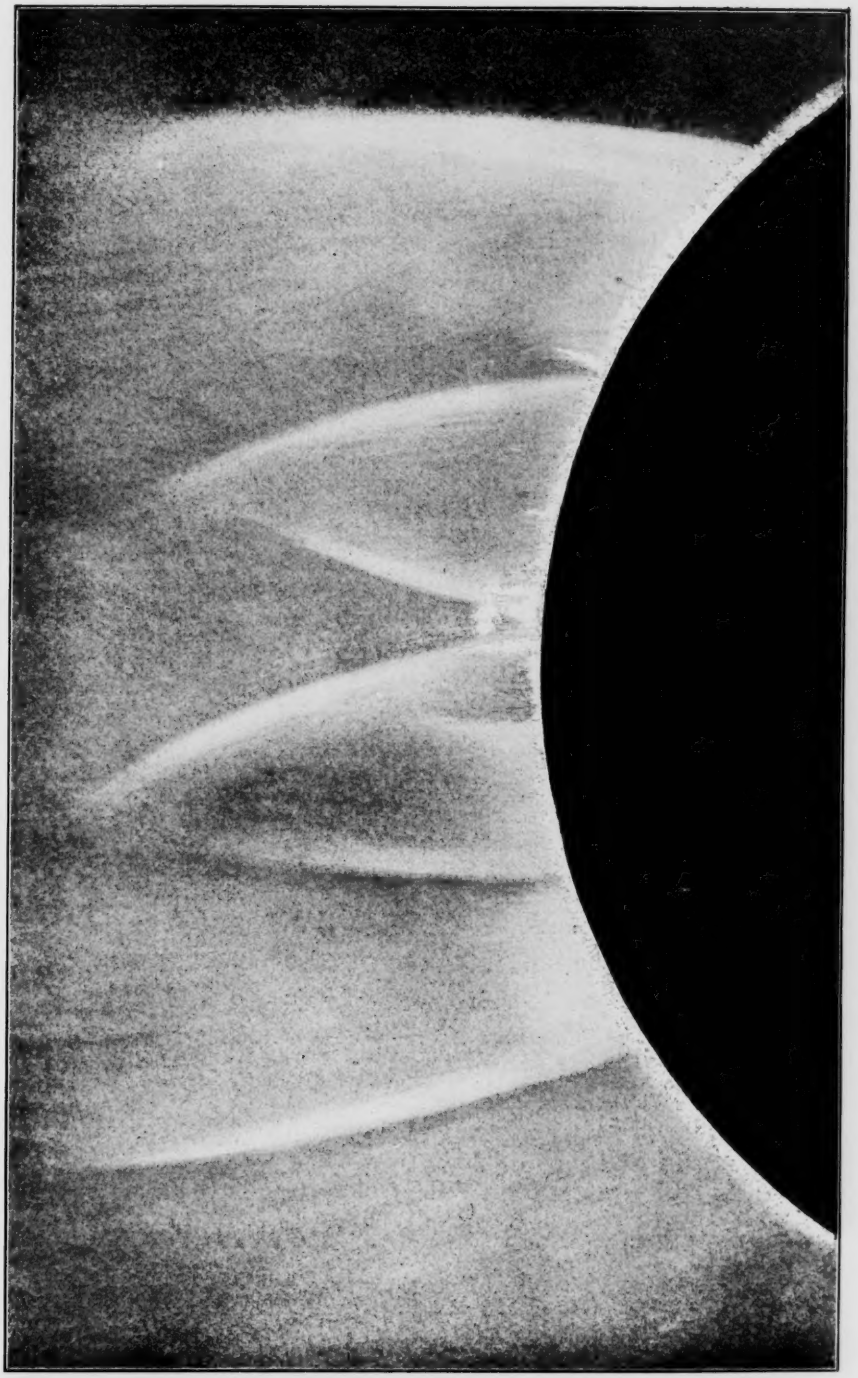

THE CORONA OF 1900, MAY 28 (S.W. QUADRANT).

From a Drawing by Miss Lilian Martin-Leake, with a 3-inch Refractor, at the Hotel de la Regence, Algiers.

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least the coronal rifts are neither contrast effects nor mere interspaces between bright rays, but are caused by the interposition of actual dark absorbing matter between ourselves and the general diffused coronal glow. The form of the corona, as it appears to us, is therefore not wholly an emission, but partly an absorption effect.

SOME EARLY THEORIES ON FERMENTATION.—II.

By W. Stanley Smith, ph.d.

(*Concluded from page* 155.)

Van Leeuwenhock, 1632—1723, was the first to behold the beautiful cells of the yeast plant, *Saccharomyces*, and he it is who first records their morphology. It is, however, all too certain that Van Leeuwenhock passed away unconscious that his cells were endowed with life; they were to him "globulis nempe ex quibus farina," mere globules of starchy nature derived from the cereals, wherewith the early brewer prepared his wort. More than a century and a half must perforce roll by ere Caignard de la Tour, in France, and Schwann, in Germany, could proclaim the vital nature of our yeast. The former man of science, observing that it lacked the power of motion, dubbed yeast a plant, and proclaimed this plant to be the first cause of alcoholic fermentation. Schwann, on the other hand, arrived at the same conclusions, only by a very different method of reasoning. He believed that only mineral poisons were fatal to plant-life, whereas animals succumbed to both mineral and vegetable toxicants. He found his yeast-plant unharmed by strychnine, whilst it succumbed to the presence of arsenic. In order to illustrate the veritable depth of learning achieved by Schwann, we must quote some few of his words. "It is impossible," says he, "to mistake the connection between fermentation and the growth of the sugar-mould, and it is highly probable that the growth of this mould is the cause of the phenomenon attending fermentation. As, however, it is necessary, in order to produce a fermentation, to have a nitrogenous substance present, as well as sugar, it seems that the presence of nitrogen is a condition which must be complied with for the purpose of furthering the development of this plant, and hence, that the plant itself contains nitrogen." These last words may be read in connection with those of an Italian chemist, Fabrioni, who in 1787 discovered the yeast ferment to be what he termed a "vegeto-animal" substance—that is, a body which gives off ammonia when burned, and is similar to the albumen and casein of animals, or the gluten of plants.

Turn to the dryest of dry-as-dust journals, the *Annalen der Pharmacie*, and selecting Volume XXIX., read from page 100, onwards, "When yeast is shaken up with water it appears, if examined under the microscope, to consist of infinitely small globules, and of fine threads, unquestionably composed of some kind of albumen. If you place these globules in sugar-water, it becomes evident that they are the eggs of an animal; they swell, burst, and therefrom issues a minute organism which reproduces itself with astounding rapidity, and by a hitherto unknown method. The appearance of this animal differs widely from any of the six hundred species at present described; it is like a Beindorf distilling flask, without the condensing tubes. The neck of the flask, which acts as a sucking trunk, is lined with fine hairs, but both eyes and teeth are missing. Stomach, intestines, anus (a small rose-coloured point), and urinary organs are all developed. At the moment of release from the egg, one can see the animals imbibe the sugar-water with great relish, and also witness the passage of the sugar into their stomachs. Digestion follows at once, and alcohol passes from the intestines whilst carbonic acid escapes from the urinary organs. . . . If the liquid be boiled, fermentation ceases, because the animals are unable to live at such high temperatures. Excess of alcohol, sulphurous acid, or any mineral acids, are likewise fatal to these creatures." Thus writes the ribald scoffer, and with diabolical ingenuity explains that, all the sugar being decomposed, these marvellous creatures of his fancy eat one another, "digesting everything but the eggs, which pass out once more and furnish material for further fermentation."

Despite this obvious satire (one wonders how it ever got into the *Annalen*), the vital theory of fermentation would, in all probability, have been accepted, had it not happened that another giant intellect visited our orb, in the person of Justus von Liebig. It must be related of Liebig that he opposed the vital theory of fermentation, but when he came across the memorable words of Ernst Stahl, he undoubtedly brought the full force of a chemical mind to bear upon them, and so we find the molecular theory of Justus von Liebig is an amplification of that espoused by Ernst Stahl, extended and fulfilled by some few facts his experiments had taught him. We can thus present the Liebig theories:—The component particles of a decomposing body are in constant motion, and this motion is, of a necessity, conveyed from one body (the cause of fermentation) to the substance with which it is in intimate contact (*e.g.*, the dissolved ingredients of the brewers' worts). Liebig exerted his knowledge to the utmost in order to gainsay his opponents, and we can find numerous echoes of his opinions on these matters, interspersed between the lines of sundry volumes, translated, in his early years, by the late Lord Playfair, as well as in the translations of Liebig's works furnished by Gregory and Blyth. It seems passing strange to us that a mere mechanical theory should have taken root, when Caignard de la Tour, Schwann and Turpin, had spoken; but such it was, and until Pasteur had dashed their idols to the ground, a process further effected by Tyndall and Huxley in later years, men scoffed for the most part at Turpin's remarkable words. They run thus, and we will accept them as truth until convinced to the contrary: "Vegetation as cause, and fermentation as effect, are two things inseparable in an act of sugar decomposition."

Berzelius, who, said Prof. A. W. Williamson, "had been for a lengthened period the one great man in the domains of inorganic chemistry," and who himself declared he had made his greatest discovery in unearthing apothecary Scheele, laid siege to both the theories of Schwann (vital forces) and Liebig (mechanical forces), and steered his way through the mudbanks of controversy by declaring the characteristics of yeast to be but the natural attributes of an amorphous precipitate. Also one Ehrenberg declares that many amorphous deposits may be observed in wreath-like forms, a bare initial fact revealed by hasty microscopic peeping. The Swede, Berzelius, did, of a surety, endow his amorphous precipitate with certain catalytic forces, and we find, in the pages of *Poggendorfs Annalen*, a well-known man, called Mitscherlich, came to somewhat like conclusions. He, Mitscherlich, describes his force as that of contact, and quotes, with due erudition, the mysterious action of platinium sponge on hydrogen per-oxide. And yet

XUM

more theories echo from these times, mostly buried now in the tombs of Meissner, who verily believes the action of yeast is purely chemical, of Colin and Kämtz, and other men of science, who deem the whole matter connected with electrical phenomena.

Let us just put together the three or four main schemes of fermentation, as set forth by as many eminent philosophers. In the first place, we will put the vital theory, so well defined in Turpin's words already quoted. It finds support, at one time and another, from Caignard de la Tour, Schwann, Kützing, Van der Brock, Bichat, and lastly the illustrious Pasteur. As against this vital theory, we must place that of mechanical forces, originated by Stahl and Willis, and championed by Justus von Liebig, aided and abetted by Gerhardt. Then, again, the theory of catalytic forces, or contact-action, as set forth by Berzelius and Mitscherlich, has to be reckoned with, so that when, in the fulness of time, Pasteur uttered his mandate, it brought immense relief to the minds of all concerned therewith. "My firm opinion," said Pasteur, "is that the chemical act of fermentation is a correlative phenomenon of a vital act, both beginning and ending with such an act. I cannot conceive the possibility of alcoholic fermentation, without there being, at the same time, organisation, development, growth of new globules or the continuation of consecutive life of globules already formed."

The question now naturally arises, whence came these globules? The records of earliest times teach us of races of human beings who are deeply convinced of the truth of spontaneous generation, allied, in some cases, to an erudite philosophical conception which declares life itself is but an, almost, chance attribute of certain molecules, which themselves form the basis of all things living.

But perhaps it is chiefly due to a deep-thinking Catholic priest, Needham, Fellow of the Royal Society, that the true cause and nature of fermentations was first suggested. How he sprang upon the idea of boiling solutions in bottles, and then closing them up, we can scarce relate, but it is to his eternal credit that he actually did first boil and then seal, and thereby Needham obtained the master-key which unfolded the portals guarding all the glories of modern bacteriology. We are reluctant to record that Needham's boiled solutions did not keep for any length of time, but another learned cleric, one Spallanzini, soon defined the reason thereof, and, having subjected the liquids to prolonged ebullition, he straightway hermetically closes his flasks. In such-like manner was the time-honoured theory *generatio aequivoca*, of spontaneous generation, first laid in dust and ashes. Men began to realise what marvels and mysteries were borne on each passing breeze; they divined the *ursprung* of the fermentations that attacked sugar solutions and meat broth; and, moreover, the teachings of science were applied in most practical manner, as in the classic arrangements of Appert. Scheele was the first to initiate the process we now call "pasteurizing," or the sterilization of changeable materials by heat.

From many experiments, Gay-Lussac (1778-1850) was enabled to utter forth strange revelations as to the robbery of oxygen from the air imprisoned in hermetically closed flasks containing putrescible materials, whereby men had but little difficulty in connecting this gas with the urgent demands of all life. And from these points onwards we have witnesed the teachings of Pasteur and Hansen, the former of whom has already been cited, whilst the latter, as the great biological and botanical expert of yeasts, does not come directly under the category of subjects we are at present discussing.

The present-day theorists are divided into two distinct schools, namely: those concerned with the vital theory, and the others who, to some extent, espouse a reversion to older chemical hypotheses known as Professor Buchner's zymase theory. The learned Tübingen professor succeeded in extracting from living yeast cells an enzyme, or soluble ferment, which he calls zymase, and which has been proved capable of inducing the same alcoholic fermentation as that hitherto accredited only to the living and multiplying yeast cells. Numerous other men of science have confirmed these startling experiments, amongst others, our English botanist, Reynolds Green, who detailed his work on the subject at the Bristol meeting of the British Association for the Advancement of Science. The idea is in reality a revival of similar theories advanced half-a-century ago by Traube and Hoppe-Seyler, but Buchner has been able to support his hypothesis by actual experiment, an indispensable adjunct lacking in many earlier commentaries on fermentation. The battle is still being waged, and it is not possible for us, at present, to adjudicate victory to either side.

In conclusion, we must offer most humble apologies to a vast host of learned shades, the offspring of whose imaginative brains we have had neither leisure nor desire to exhume. Their strange theories, and stranger personalities, belong to a long-vanished past, and we have not deemed it wise to drag them from out the "dark backward and abysm of Time." Our barque has been borne, with exceeding rapidity, down the stream of many ages; it only remains for us to ask, Where will she find a haven in the centuries to come?

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

BIRD PROTECTION. — At the annual dinner of the British Ornithologists' Union the following excellent resolution was proposed by Mr. E. G. B. Meade-Waldo, seconded by Mr. H. M. Upcher, and carried unanimously:—"That any member of the Union, directly or indirectly responsible for the destruction of nest, eggs, young or parent-birds of any of the species mentioned below—Osprey, Kite, White-tailed Eagle, Honey Buzzard, Common Buzzard, Hoopoe, Golden Oriole, Ruff, Bittern and Chough—should be visited with the severest censure of the Union." It is to be hoped that this resolution will deter those members who are in the habit of purchasing British taken eggs from buying the eggs of these birds, and thus becoming indirectly responsible for their destruction. All the birds mentioned will require the strictest protection in Great Britain for many years before they can again become at all numerous. All the laws—and now there are many for bird protection—are practically useless as long as buyers of eggs and skins insist on having British taken specimens. And, after all, it is only a matter of sentiment that the eggs or birds should be British taken. There are many places abroad where the species named above are common, and the birds and eggs taken there are precisely similar to those taken in England or Scotland. And yet ornithologists, who know perfectly well that these birds are fast dying out in Great Britain, create a demand for their eggs and skins. We know of a dealer—would that we knew his name—who has lately taken many clutches of the eggs of the Kite in Wales, where these birds are said to still "hold their own!"

The Great Shearwater in Scottish Waters. By Alfred Newton, M.A., F.R.S. (*Annals of Scottish Nat. Hist.*, July, 1900, pp. 142-147.) This is a very interesting contribution from the pen of Prof. Newton, who, in company with Mr. Henry Evans, on two separate occasions saw an extraordinary number of these birds off the west coast of Scotland. On the 27th of June, 1894, between thirty and fifty pairs were seen between Lewis and North Rona, while on June 24th, 1895, a still greater number were seen near St. Kilda. Prior to this the known instances of the occurrence of the Great Shearwater in Scottish waters did not amount to many more than six. A point of great general interest was brought out by this "visitation" of Great Shearwaters. Several specimens were obtained by the fishermen of St. Kilda. From the examination of these birds, other skins and figures, Prof. Newton comes to the conclusion that members of the group *Tubinares*, which contains some of the birds best endowed with the power of flight, so moult their wings as to become almost, if not quite, incapable of it.

Scops Owl in Shetland. (*Annals of Scottish Nat. Hist.*, July, 1900, p. 184.) Mr. Eagle Clarke has received a wing and leg from the island of Foula, which he identifies as those of *Scops giu*. The bird was first seen in April of this year, and was eventually captured and kept in confinement. The recorded instances of this Owl in Scotland are very few in number, and it has never before been known to visit the Shetland Islands.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

The Annual Awards of the Royal Geographical Society.—The annual awards of the Society have been made as follows for the present year: The Founder's Medal to Captain H. H. P. Deasy, for the exploring and survey work which he has accomplished in Central Asia; the Patron's Medal to Mr. James McCarthy, for his great services to geographical science in exploring and mapping all parts of the Kingdom of Siam; the Murchison Award to M. H. Arctowski, for the valuable oceanographical and meteorological work which he performed on the Belgian Antarctic Expedition; the Gill Memorial to Mr. Vaughan Cornish, for his researches on sea-beaches, sand-dunes, and on wave-forms in water; the Back Grant to Mr. Robert Codrington, for his journeys in the region between Lakes Nyasa and Tanganyika; the Cuthbert Peek Grant to Mr. T. J. Alldridge, for his journeys during the past ten years in the interior of Sierra Leone.

Notices of Books.

"Pre-Historic Times." 6th Edition. By the Rt. Hon. Lord Avebury. xxiii. and 314 pp. Illustrated. (Williams and Norgate.) 18s. The distinguished author (better known as Sir John Lubbock) of this ever-popular work is to be heartily congratulated on the issue of its sixth edition. Since the publication of the second edition in 1869 no special preface has appeared, and it is therefore necessary to compare the present volume with the fifth edition (1890) in order to see how much it has been improved. The number of pages is somewhat less than in its predecessor, but the plates have been greatly increased in the present issue, partly owing to many of the figures which formerly appeared in the text having been incorporated in the plates. Specially noticeable is the replacement of the coloured frontispiece of the fifth edition by an exquisite photogravure of the well-known tumuli at Upsala; and there can be no question in its present guise, so far as illustrations are concerned, that the sixth edition is immeasurably superior to the fifth.

Numerous additions have likewise been made in the text in order to aid in bringing the book abreast of modern advances in science, the work of the Messrs. Sarasin on the Veddas of Ceylon being alluded to (perhaps too briefly) on p. 415, while Prof. Hughes's memoir on prehistoric and other cattle receives mention on p. 195. Strangely enough, however, the author seems to be unaware of the existence of a work entitled "Wild Oxen, Sheep, and Goats of All Lands," published by Mr. Rowland Ward in 1898, in which many of the views advanced in the present volume are controverted. And in regard to both wild and tame members of the genus Bos the author would have done well to have consulted a specialist, or at least to have walked carefully through the galleries of the Natural History Museum. We should not then have been told that the European bison is now confined to Lithuania (p. 197), or that it is identical with the aurochs. Neither would the reader have been puzzled by the confusion in regard to the proper scientific name of the extinct wild ox of Europe (the true aurochs), as will be apparent by comparing the tables on pp. 188 and 223. Again we find the elk, roebuck (p. 188), and reindeer (p. 268), which respectively represent three totally different genera, all included in the genus Cervus, whereas the so-called Irish elk, which is a Cervus, figures as a genus apart (p. 268). As another example we may notice that the marten appears as Mustela martes on p. 188, and as Martes sp. on p. 223; and many other similar instances might be cited. Nor are misprints by any means wanting, as, for instance, Sus pulustris on the head-line of p. 192, instead of Palustris, Cervus elephas, p. 223, for Elaphus, and Lagomys fusillus, p. 279, for pusillus.

These critical remarks are made in no hostile spirit, but rather to emphasize the necessity for calling in the aid of a specialist when an author has to deal with a subject in which he is not thoroughly at home.

As a matter of fact, it is the portion relating to mammals which forms the one weak part in the book, upon which in other respects we have nothing but praise to bestow. Were it a new work, we should call the reader's attention to the extremely interesting chapters relating to stone and bone weapons of all kinds, and also to the fascinating section devoted to the manners and customs of modern savages, but in the case of a work which has already obtained such a world-wide reputation this would obviously be superfluous, not to say impertinent. We may therefore conclude by the expression of the hope that the patronage accorded to the sixth edition of this famous work may be fully as extensive as that with which its forerunners were received.

"The Distribution of the Negritos in the Philippine Islands and elsewhere." By A. B. Meyer, M.D. pp. 96. (Dresden: Stenzel & Co.) 1899. The chief object of this excellent little work seems to be to disprove the widely spread idea that the short, round-headed, frizzly-haired, black people commonly known as Negritos form a substratum of the population over a large extent of the Malayan countries, and that they also occur in Formosa, as well as in certain districts of China, Japan, India, etc. For this theory, which was adopted by the late Sir William Flower, the French anthropologist Professor Hamy is mainly responsible. As the result of his investigations, the learned Director of the Dresden Museum (who has personally visited the Philippines, New Guinea, and many of the Austro-Malayan islands) comes to the conclusion that the typical Negritos are restricted to certain islands of the Philippine group, the Andamans, and some districts in the Malay Peninsula. In the Philippines these people are more numerous than elsewhere, although even there they form only a comparatively small proportion of the population.

A very important section of the work is devoted to the consideration of the relationship of the true Negritos to the Melanesian inhabitants of Papua, who are typically of taller stature, with a long and narrow type of skull. Short-headed people are, however, to be met with in Papua, who have been considered to represent a distinct Negrito race. But, following the lead of Mr. Muclay, Dr. Meyer is of opinion that Negritos and Papuans are essentially one and the same race. "A Negritic race," he writes, "side by side with the Papuan race nobody has been able to discover just because it does not exist, and it does not exist because the Papuan race, in spite of its variability, is on the one hand a uniform race, and on the other as good as identical with the Negritos."

Finally, Dr. Meyer is very emphatic on the futility of the craniometry as now practised, remarking that "the practice of describing a skull in detail will never lead to profitable results, and only burdens the literature of the subject beyond measure."

"Micro-Organisms and Fermentation." By Alfred Jorgensen. Translated by A. K. Miller, Ph.D., and A. E. Lennholm. Third Edition. xiii. and 318 pp. (Macmillan.) 10s. net. So rapid is the growth of the branch of science with which this book deals that though the first edition appeared only seven years ago the author has found it necessary, in order to incorporate the new work accomplished in the interval, to entirely rewrite a large portion of the book and to enlarge it very considerably. The new edition differs from its predecessors in containing a biological treatment of several English high-fermentation yeasts, isolated from yeast used in breweries and distilleries in various parts of Great Britain; an account of the changes recently discovered occurring in yeast during its use in factories; and a description of lactic acid bacteria, and the use of pure cultures of them in dairies. We find with regret that the volume is not provided with an index. This is a somewhat serious omission in a technical book of this nature, which will be so largely employed as a work of reference. Fortunately this defect can be easily remedied, and we trust the translators will see that a complete index is provided in the next issue. The text is accompanied

by some eighty-three clear and instructive illustrations, while the bibliography at the end of the volume, occupying as it does over forty pages, will prove of real service to students of bacteriology and to the scientific brewer.

"The Principles of Mechanics." By Heinrich Hertz, translated by D. E. Jones, B.SC. (Macmillan.) 10s. net. "Presented in a new form" is the claim put forward in this treatise on the principles of mechanics. In it the author has endeavoured to give a consistent representation of a complete and connected system of mechanics, and to deduce all the separate special laws of this science from a single fundamental law which, logically considered, can, of course, only be regarded as a plausible hypothesis. He has chosen as his starting-point that of the oldest theories, namely, the conception that all mechanical processes go on as if the connections between the various parts whch act upon each other were fixed, a method of procedure in which much scientific insight and imaginative power are required, and, with all its imperfections, the logical system of dynamics thus evolved with the greatest ingenuity and perfect mathematical form will be appreciated as a guide to the general characteristics of natural forces. It is a work unsuited for the systematic teaching of mechanics, in spite of the fact that it affords a complete survey of all the more important general propositions in mechanics. All the principles are there, it is true, just as the chemical composition of water is the same at the Poles and the Equator, but to bathe in the Arctic Ocean one needs hardening a little, and to read this book with profit it is necessary to approach it through a milder medium.

"Practical Physiology." 7th Edition. By M. Foster and J. N. Langley. (Macmillan.) Illustrated. 7s. 6d. Sir Michael Foster's book, first printed in 1876, and now having reached the 7th edition under the care of Drs. Langley and Shore, needs but a few words of explanation as to the modifications introduced in order to meet the present day requirements. While the original general arrangement remains practically the same, the sections dealing with chemical physiology and the physiology of muscle and nerve have been extensively revised, and we note with some regret that the portion on the dissection of the rabbit and dog has been omitted, because, as the authors say, "the specialization of study which has taken place in the last twenty-five years seemed to make this omission inevitable." Still, in our opinion, the book in its amended form will maintain a foremost place among laboratory manuals of its kind.

"Man and His Ancestor." By Charles Morris. vii. and 238 pp. (New York: The Macmillan Company.) 5s. Towards the end of his book Mr. Morris describes its purpose as being "to trace the evolutionary origin of man, in his ascent from the lower animal world to his full stature as the physical and intellectual monarch of the kingdom of life" (p. 225). We had come to the conclusion, before reaching his concluding chapter, that Mr. Morris had succeeded in giving, in a very attractive manner, a fair exposition of the present state of evolutionary ideas on the ancestry of man, so that we are able to congratulate him upon having satisfactorily completed the task he set himself. Starting with a rapid review of the vestigial structures found in the human body, Mr. Morris proceeds to detail the various relics of ancient men which have been discovered in different localities. The questions of the transition from quadruped to biped and the steps which led to a complete freedom of the arms are then dealt with, after which less technical subjects are considered, such as, the development of intelligence, the origin of language, the evolution of morality, and man's relation with things spiritual. We surmise that the majority of people who study books of this class are more directly interested in the theory of evolution so far as it takes notice of the moral side of man's personality, and they will be most anxious to know how this subject is handled. One or two sentences will serve sufficiently to indicate the author's view. "What we call sinfulness is largely a matter of custom and convention. Men cannot properly be said to sin when their actions are checked by no conscientious scruples, and what one people would consider atrocious instances of wrong-doing, might be looked upon as innocent and even estimable by a people with a different moral standard" (p. 221). Sometimes Mr. Morris shows an unfortunate disposition to forget his scientific resolutions and indulges in fanciful language, which is out of place in a serious treatise, e.g., "The love principle is the innate moral element of the universe. Its rudimentary form is the attraction between atoms, which expands into the attraction between spheres. We see a development of it in the magnetic and electric attractions, and a higher one in the sexual attraction that exists in the lowest organisms. Its expansion continues until it reaches the high level of human love and social sympathy" (p. 217).

There is now in the press, and will shortly be published by Messrs. Young in Liverpool, and Messrs. Porter in London, the Report on the conjoint expedition to Sokotra and Abd-el-Kuri, conducted in 1898-9 by the British Museum (represented by Mr. Ogilvie-Grant, of the Zoological Department) and the Liverpool Museums (represented by the Director of Museums to the Corporation, H. O. Forbes, LL.D.). The expense of its publication is borne by the Museums Committee of the Liverpool City Council, and it is edited by Dr. Forbes. It will be illustrated by between twenty-five and thirty plates, chiefly coloured, depicting the zoological and botanical discoveries of the expedition, the ethnography of the islands, etc. The introductory chapters by the Editor give an interesting account, fully illustrated in the text, of the journey, of the islands, and of their inhabitants. The scientific chapters are contributed by Lord Walsingham, F.R.S., Prof. Balfour, F.R.S., Mr. Boulger, F.R.S., Dr. Forbes, Mr. Ogilvie Grant, Mr. A. E. Smith, Col. Godwin-Austin, F.R.S., Mr. De Winton, Sir G. Hampson, Bart., Mr. R. I. Pocock, and other well-known naturalists.

BOOKS RECEIVED.

A Guide to Chamounix and the Range of Mont Blanc. By Ed Whymper. (Murray.) 3s. net.

A Guide to Zermatt and the Matterhorn. By Ed. Whymper. (Murray.) 3s. net.

The Year Book of Photography and Amateurs' Guide, 1900. (*Photographic News* Office.) 1s. net.

A History of Decorative Art. By W. N. Brown. (Scott, Greenwood & Co.) 2s. 6d. net.

The Fifth and Sixth Books of Euclid. By M. J. M. Hill. (Camb. Univ. Press.) 6s. net.

Ad Astra. By Charles Whitworth Wynne. (Grant Richards.) 7s. 6d. net.

The Philosophy of Many Things. By Mary Leicester. (Lloyd.)

Text-Book of Zoology. Part I.—Mammals. By Dr. Otto Schemeil. Edited by J. T. Cunningham, M.A. (Black.) Illustrated. 3s. 6d.

First Stage Botany. By Alfred J. Ewart, D.SC. (Clive.) 2s.

Lavengro: The Scholar, the Gipsy, the Priest. By George Borrow. Minerva Library. (Ward, Lock.) 2s.

Flesh Foods. By C. Ainsworth Mitchell. (Griffin.) 10s. 6d.

Foundations of Analytical Chemistry. By Wilhelm Ostwald. Translated by George M'Gowan. (Macmillan.) 6s. net.

Functions of Squares. By M. A. McGinnis. (Sonnenschein.) 5s.

Results of Rain, River, and Evaporation Observations made in N. S. Wales, 1898. By H. C. Russell, C.M.G., F.R.S.

Domestic Science. By Thomas Cartwright, B.A. (Nelson.) 2s.

Official Year-Book of the Scientific and Learned Societies, 1900. (Griffin.) 7s. 6d. net.

Introduction to Zoology. By Chas. B. Davenport and Gertrude Crotty Davenport. (Macmillan.) 6s.

Radiographic List. (Isenthal & Co.)

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

MENTAL PERSPECTIVE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The discussion which has been occupying the attention of the members of the British Astronomical Association of late concerning the well-known, but none the less curious, apparent enlargement of heavenly bodies when seen near the horizon* has called forth several ingenious theories to account for the phenomenon. That this enlargement of the sun or moon when seen on the horizon is purely illusory is acknowledged by all, so that it is evident some kind of mental deception is here at work which tends to falsify our estimates of distance and consequently of magnitude. It has been suggested, for instance, that, when looking at the moon near the horizon, we are unconsciously aided in our estimate of its distance by reference to intervening land-marks, such as trees, hills, or houses, the distance of which we already know, whereas, when looking upward at the moon in the zenith, there is nothing whatever to guide us. Now it has been observed that the distance of objects is almost invariably under-estimated when we are deprived of our usual land-marks, as, for instance, at sea, and it is suggested that by analogy the distance of objects in the zenith, or at high altitudes, is similarly under-estimated. Thus, the moon, sub-tending, as it

* *Journal of the Brit. Astro. Assoc.*, Vol. X., Nos. 1, 3, 4 and 5.

does, the same angle to us, whether on the horizon or in the zenith, appears to us larger in the former and smaller in the latter position, for, as pointed out by Mr. John Turner,† "of two bodies of equal *angular* magnitude, that which appears to us to be nearer we think the smaller."

The truth of this statement is, I think, exemplified in a very striking manner by the accompanying photograph (Fig. 1), which shows the foreshortened side of a villa seen "under conditions different from those in which our experience is usually gained." It is, in fact, a photograph taken through a 3-inch telescope, magnifying some 40 diameters, of the villa, distant about a mile and a half, and marked by an arrow in Fig. 2, which represents the naked-eye view of the same.

Now as this building is at a considerable distance from the observer its near and far ends are seen under practically the same visual angle, or, as a draughtsman would express it, the vanishing point of its lines is infinitely remote. Instead of the lines of the roof and first story appearing to converge as they recede, as would be the case if the house were really as near the spectator as the telescope apparently brings it, they are here practically parallel, and our usual ideas of perspective are consequently upset. So much, indeed, are we in the habit of mentally enlarging the reduced image of the far end of the house (knowing it to be as large as the near end) that in the present case, where the two ends are of practically equal angular magnitude, we still mentally enlarge the distant end so that the lines of the roof and the first floor appear actually to *diverge*

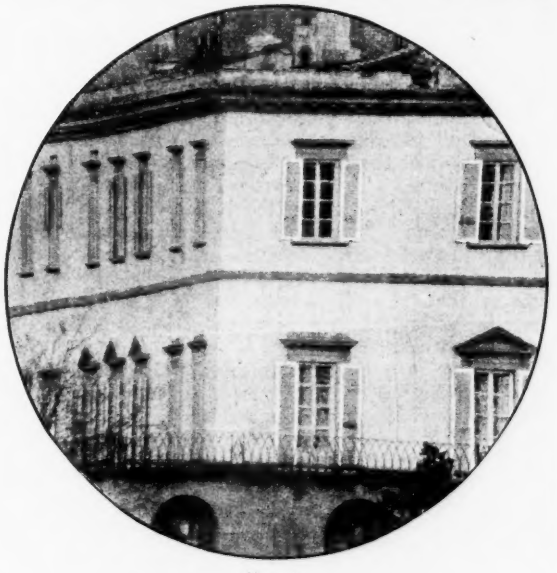

FIG. 1.

as they recede from us. That this curious effect, however, is purely due to a mental deception on our part is plainly shown by holding the picture in such a position that the eye can glance obliquely down the seemingly divergent lines, when it will at once become apparent that they are practically parallel; the slight existing convergence towards the distant end being inappreciable.

This instance of our mentally enlarging the more distant of two objects subtending equal angles seems to me to have a distinct bearing on the problem of the apparent enlargement of celestial bodies when seen near

FIG. 2.

the horizon; while the tele-photograph itself illustrates in a remarkable manner the truth, so often overlooked, that the telescopic aspect of an object (which is but the naked-eye view enlarged) is not identical with that which the object would present to the naked eye at the same apparent distance.

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34, Viale Principe Amedeo,
Florence.

† *Journal B. A. A.*, Vol. X., p. 220.

LICHEN GROWING ON QUARTZ.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The other day I was shown an entire piece of quartz upon which was growing a lichen—*Parualia Prysodes*. After carefully removing a small portion of the lichen, I examined the uncovered part for earth deposits but failed to detect any.

It is clear that the plant is rooted to the quartz, and what I am at a loss to know is from which source other than the atmosphere does this plant derive its nutriment?

I have observed lichens acting upon hard rocks, but never quartz; moreover, as you assert in your article on "Plants and their Food," KNOWLEDGE, May, 1900, that quartz is an insoluble network enclosing the mineral constituents of plant food, the phenomenon becomes all the more egregious, and its explanation would bestow a great favour upon

J. ALEXANDRE COOK.

10, Grafton Square, Glasgow,
14th June, 1900.

[Mr. J. A. Cook has reproduced in too condensed a form the remarks of Mr. Pearson in KNOWLEDGE, Vol. XXIII., p. 102, where quartz is stated to surround the other minerals in granite, which otherwise would yield up the constituents needed by plants. This, however, does not affect the point he raises. I have consulted Prof. J. B. Farmer, F.R.S., who allows me to

state that lichens growing on a surface of pure quartz may derive the very small amount of mineral nutriment required by them from blown dust, which easily accumulates about them, though in far too slight a quantity to form a soil. It may be remembered also that, while quartz-veins are fairly pure, quartzites contain a number of other scattered minerals besides quartz; hence some massive rocks, practically composed of quartz, may yet serve as a ground for the growth of lichens.

GRENVILLE A. J. COLE.]

WIRELESS TELEGRAPHY.—III.

By G. W. DE TUNZELMANN, B.SC.

MECHANICAL REPRESENTATIONS OF ELECTRIC ACTIONS.

IN my last article* some account was given of the medium through which electric actions are transmitted. All that I can do towards explaining the mechanism of transmission is to lay before my readers mechanical arrangements capable of producing the observed results, and which may not impossibly be something like the real ones, which as yet remain hidden from our view.

Clerk Maxwell was the first to give helpful suggestions in the way of mechanical models illustrating electric actions. His model was modified and improved by Professor Fitzgerald, and later Professor Oliver J. Lodge treated this question in a most exhaustive manner in a series of papers extending over the last twenty years. It is upon the store the latter has provided that I shall mainly draw at present.

We may consider ourselves as living in a sort of ocean of electricity, and as water is so much more familiar to us than electricity, it may help our conceptions to imagine for a moment that we are living under the sea, and consider the water as taking the place of the ocean of electricity really surrounding us, but the analogy then will not be quite complete. Water can be displaced by solid and other bodies, whereas in the electric ocean the amount of electricity contained within a given space is just the same, whether part of that space is occupied by matter of any kind, or whether it is what we call empty.

There is no possibility of putting electricity into any body in the way that we fill a bucket with water. When living under the water our buckets must always be full of water. We may change the water, but only by displacing it by an equal quantity from some other portion of the all-pervading ocean. As water cannot pass through the sides and bottom of the bucket, so in the same way insulators will not allow electricity to pass through them. The space occupied by the material of the bucket is not full of water, while the space occupied by an insulating material contains exactly the same amount of electricity as if the material were not there; but this will not seriously affect the use of the analogy. There is another and far more important difference between the two oceans; of water, and of electricity. While the water can move freely from one part of the ocean to another it is not so with electricity in so called empty space, this being an insulator. We find that electric waves can be sent through space, and therefore some small backward and forward motion must be possible but no continuous flow. The electric ocean must therefore be considered as entangled in a sort of jelly, which will allow of slight vibratory displacements, but in order to get a continuous flow some means of making tubes or channels in the jelly must be found, and these are called conductors.

In order to get a flow through a tube we must have some means of driving the electricity along, such as would be provided by a pump in the case of water, and for the flow to be continuous the tube must form a closed circuit. An analogy for a circuit composed partly of conductors and partly of insulators may be found in an endless tube containing diaphragms of some elastic substance, such as indiarubber, stretched across it at intervals.

A section of such a tube is shown in Fig. 1. The pump, A, has valves so adjusted as to send a current of water down the tube in the direction shown by the arrows. At B is an elastic diaphragm stretching across the tube. Before the pump is worked the diaphragm will be subject to equal pressure on opposite sides, and will therefore remain flat, as shown in section by the straight line, a, b, c. By working the pump the pressure on the right-hand side of the diaphragm will be increased and that on the left diminished, and the diaphragm will be bent into some such form as is represented by the curved line. If diaphragms are placed across the tube at each side of the pump, A, and the pump is then removed, and the tube divided through the diaphragm so as to leave each end enclosed, two tubes with their diaphragms will appear, as shown in Fig. 2, and the right-hand half of the tube will contain more and the left-hand half less than half of the water originally in the tube. These two tubes represent two equally and oppositely charged conductors, and it will be seen that according to this representation it is impossible to charge a conductor positively without at the same time giving an equal negative, or opposite charge, to some other conductor.

The greatest visible effects are produced when the whole of one conductor is brought as near as possible to the whole of the other while maintaining insulation between them. This is very conveniently done by pasting sheets of tinfoil on the inside and outside of a glass jar or on the opposite faces of a sheet of glass, forming the well-known Leyden Jar, and it will be seen that this consists simply of a pair of conductors insulated from each other, and that the case of charging or discharging any conductor is a case of the charge or discharge of a Leyden Jar.

Professor Lodge has designed an elaborate model of a Leyden Jar; Fig. 3 being a skeleton diagram, and Fig. 4 an illustration of the actual model.

A thin indiarubber bag is tied over the mouth of a tube provided with a stopcock, A, and the tube is inserted by means of a cork into a three-necked globular glass vessel. One of the other openings must have a stopcock, B, while the third opening is closed with a cork, or preferably another stopcock, as soon as the whole vessel, both inside and outside the bag, is filled with water free from bubbles of air. A third tube, usually closed by a stopcock, C, represents a discharger; and open gauge tubes, a and b, represent electroscopes attached to the two coatings of the jar respectively, while a water pump screwed on to A corresponds to a source of electricity, such as a battery, or a frictional or influence machine. If the two terminals of the source are attached to the two coatings of the jar, then A must be connected to B by means of a tube, while if one terminal of the source and one coating of the jar are connected with the earth, the more usual arrangement, then A and B must both be connected with a tank of

* KNOWLEDGE, May, 1900.

water representing the earth. In this model the gradual distension of the indiarubber bag represents the charging of the jar. In Fig. 4, two extra stopcocks, A′ and B′, leading direct to the tank, have been added, to save the trouble of disconnecting the pump in order to connect A directly with the tank, when illustrating the charging of a jar by alternate contact.

If the two tubes shown in Fig. 2 are placed together so as to form a single ring with two diaphragms across it, both in a state of strain, then if one of these is

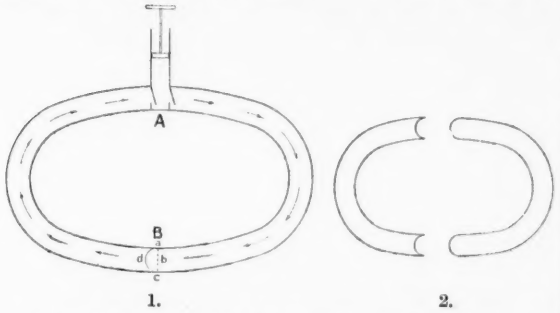


Fig. 1.—Hydraulic Model of a Circuit consisting partly of Conductors and partly of Insulators.

Fig. 2.—Hydraulic Model of a pair of equally and oppositely charged Conductors.

broken the pressures on the opposite sides of the remaining one will become equalised, and therefore the diaphragm will return to its normal condition of flatness. Owing, however, to the elasticity of the material of the diaphragm, there will be a slight oscillation on either side before it permanently assumes its position of equilibrium. As far back as 1853, Lord Kelvin showed mathematically that in general the discharge of a Leyden Jar was oscillatory, and in 1859 and subsequent years Feddersen confirmed this experimentally.

A current of water cannot be started or stopped suddenly, and similarly it is found that when an electric current is started it takes an appreciable time, though a very small one, to attain its full strength. Again, when an electric current is arrested by breaking the circuit, a very much larger spark is obtained than the one observed on closing the circuit, and the more sudden the break the larger the resulting spark. If, however, an electric current really possesses inertia, as a stream of water does, it should give rise to mechanical as well as to electrical effects. These have been looked for in vain by Clerk Maxwell, Professor Lodge, and others. It may be that an electric current consists of two equal streams in opposite directions; or, again, perhaps the hydraulic analogy is only of use in explaining a few of the more obvious phenomena; and it certainly does not account for the existence of the magnetic fields in the neighbourhood of conductors carrying electric currents or any of the phenomena depending on them.

The existence of these magnetic fields leads, moreover, to the question whether we can regard the electricity as forced along the conductor by a simple pressure, analogous to that which drives water along a pipe, or whether the energy required to maintain the flow is transmitted through the insulating medium to every portion of the boundary between it and the conductor. Professor Poynting has shown that the latter is really the case. The energy which drives an electromotor, for instance, or maintains a series of electric lamps, is not conveyed through the conducting wires. The dynamo gives its energy to the surrounding medium, thereby inducing certain strains in it which spread in all directions. If there were no conducting wires a permanent condition of strain would be set up in the medium, and when the energy reaches the conductors some of it is dissipated, and the continuous flow of a current of electricity thus becomes possible. When an attempt is made to transmit too much energy by means of an electric cable it is the insulation and not the copper wire which gives way.

An electric current does not start simultaneously at every point in the section of a conductor, but the starting or stopping begins at the outside, and penetrates inwards the more rapidly the worse the conductivity of the material. If this were infinite the current would never penetrate beyond the outer skin of the conductor.

Professor Lodge illustrates this by the experiment of spinning a tumbler of liquid, with some small particles in suspension, to make the motions of the different portions visible. The outer layers begin to move first, and the motion gradually penetrates inwards, and when the spinning of the tumbler is stopped the outside portions of the liquid stop first. If the liquid is very viscous, like treacle, the motions spread rapidly, corresponding to a bad conductor of electricity, but if extremely mobile then the inward propagation is much slower, corresponding to a good conductor. The analogue of a perfect conductor would be found in an absolutely non-viscous liquid, and in such the motion would never penetrate beyond the outermost skin.

Suppose now we wind a conductor into a coil and pass an electric current through it. We find that it behaves in every way as a magnet, in fact it is a magnet as long as the current continues to flow; hence Ampère's theory that magnetic substances owe their properties simply to electric whirls in their molecules. These whirls are not confined to the iron or steel of a magnet but spread into the surrounding space, forming what is

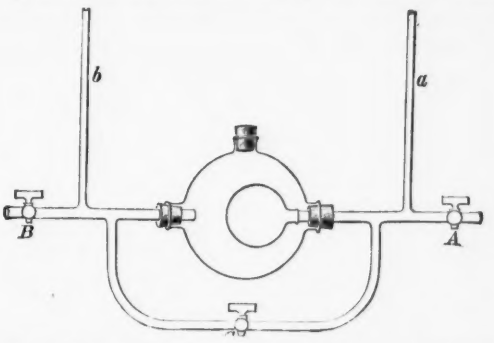


Fig. 3.—Skeleton Diagram of Lodge's Hydraulic Model of Leyden Jar.
From Lodge's "Modern Views of Electricity."

known as the magnetic field, and this may be mapped out by means of iron filings which cling, end to end, along lines coinciding at every point with the direction of the magnetic force, and are known as "lines of force." These lines of force must constitute the axes of molecular whirls, and every such line forms a closed curve, part of which is in the iron, and the remainder in the air or other surrounding media. The effect of such whirls, if they consisted of a material fluid, may be illustrated by means of a model suggested by Professor Lodge.

XUM

Two circular boards connected by elastic walls form a drum which can be filled with liquid. The upper board is then hung from a horizontal whirling table, while a weight is suspended from the lower one. When the drum is spun round, the sides bulge out, and the ends approach each other, raising the weight. A magnetic field will be represented by means of a number of chains, each made by attaching drums end to end, and following the contour of a line of force in the field. It will be seen then that when rotation is set up the end boundaries will be drawn together, representing magnetic attraction, while the lines of force drive each other apart sideways, representing magnetic repulsion.

Professor Lodge indicates the whirls in an insulating medium by means of cogwheels gearing into one another and also into those of the conductor, and in order to get over the difficulty that two contiguous wheels must be rotating in opposite directions, he assumes them to be equivalent to positive and negative electricity alternately. One of these models, representing a section of a magnetic field, is illustrated in Fig. 5, the wheels representing positive electricity being marked +, and those representing negative electricity being marked —.

If these rotate alternately in opposite directions the electrical rotation or circulation in the field will be all in one direction. In a medium of this kind, with all the wheel work revolving properly, there will be nothing of the nature of an electric current, for at every point of contact of two wheels positive and negative electricity respectively are travelling at the same rate in the same direction, but a current may evidently be represented by making the wheels gear imperfectly and work with slip, and a line of slip among the wheels will represent a linear current.

Professor Lodge points out that such a line of slip must always form a closed curve, as is required by the fact that electricity must flow in a closed circuit. For if only one wheel slip, the current coincides with its circumference; if a row slip, the direct and return circuits are on opposite sides of the row; and if an area of any shape with no slip inside it is enclosed by a line of slip the circuit may be of any shape but always closed.

In an insulator or dielectric there is no slip in the gearing, so a conduction current is impossible, but a metallic conductor must be considered as a case of friction gearing with more or less lubrication and slip; thus, turning one wheel will only start the next one gradually, so that, until all the wheels are in full spin, there is a momentary current. In a perfect conductor there must be no gearing, and such faultless lubrication that no spin can be transmitted from one wheel to another.

In a magnetic medium, which is not magnetised, the whirls are to be considered as taking place about axes pointing indiscriminately in all directions, or, more accurately, according to the researches of Professor Hughes, the various chains of whirls must form closed curves within the magnetic substance.

When the medium is magnetised these are broken up, and a preponderating orientation in a certain direction takes place, and this may be most simply treated by assuming that a certain proportion of the whirls are accurately faced in this direction, the others facing equally in all directions.

When a magnetic disturbance is propagated through an insulator in which all the wheels gear perfectly into each other, propagation of spin through the mass will take place with extreme rapidity, as there can be no slip, but only a slight distortion and recovery. In a conductor, on the other hand, so long as the spin is either increasing or decreasing, slip will be going on throughout, and a certain time will elapse before a steady state is attained. In highly magnetic substances, such as iron, and in a lesser degree nickel and cobalt, we know that this time is greatly increased, and may be represented in our model by increasing the mass of the moving wheelwork, either by giving greater mass to each of the wheels or by taking more of them, or by a combination of the two methods.

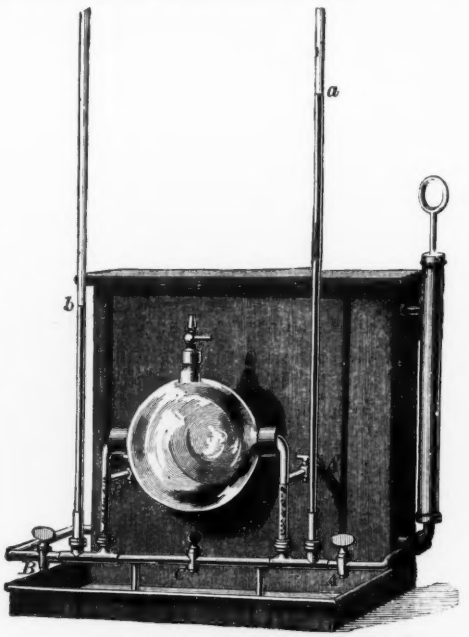


FIG. 4.—Lodge's Hydraulic Model of Leyden Jar.
From Lodge's "Modern Views of Electricity."

Take the case of a current in a copper wire gradually increasing and producing magnetic spin in the surrounding medium. A section of the field through the wire may be represented by a rack gearing into a train of wheelwork, as shown in Fig. 6. As soon as the rack begins to move the wheels will begin to rotate until the whole of the surrounding medium is in a whirling condition. Previous to a steady state of spin being attained the motion of the rack will be opposed by the inertia of the wheelwork, representing the opposing E.M.F. of self-induction, or electro-magnetic inertia, and, when the medium is in a state of spin, the stopping of the rack will be opposed in a similar manner. If the diagram is rotated round the rack the wheels become circular vortex rings. As the distance from the rack increases their cores increase in diameter, and therefore the rate of spin diminishes, until at great enough distances the medium will hardly be disturbed. Slip takes place entirely along the wire, while the axes of spin are at right angles to it. If slip could take place without friction, and the consequent dissipation of energy in the form of heat, we should have the analogue of a perfect conductor, if such a substance existed. As a matter of fact no such substance is known, and, therefore, in order to maintain a current in a conductor, the energy continually being dissipated in the form of heat must be continually supplied from some source of power, such as a dynamo or battery.

I want now to apply the foregoing representations to the explanation of the action of a telegraph wire as employed in ordinary telegraphy. What happens here is that a magnetic field at the sending station is made to excite a magnetic field at the receiving station with comparatively small loss. The wire makes it possible to produce this secondary field in any place desired. To understand how this is to be explained we will return to the consideration of the rack and train of wheels, but in the first place assume for greater simplicity that the wire is a perfect conductor. The rack must there-

FIG. 5.—Lodge's Model illustrating a Section of a Magnetic Field.

FIG. 6.—Lodge's Model illustrating a Section, taken through the wire, of a Wire carrying an Electric Current with its Magnetic Field.

FIG. 7.—Illustrating a Magnetic Vortex Whirl encircling a Wire carrying an Electric current.

From Lodge's "Modern Views of Electricity."

fore be removed and replaced by a smooth rod, so that the magnetic spin may cease at its surface and transmit no energy into the wire. Assume at the same time that the rotation of the wheels is in some manner maintained just as if the rack were being pushed along. Then in the bounding surface of the rod representing the conducting wire there exists the state of slip, which has been shown to correspond with an electric current, and it will be seen that the function of the rod or conductor is simply to provide a space free from the magnetic wheelwork, so as to allow of the free rotation in opposite directions of the wheels on the opposite side of any longitudinal section through the rod. If the space were not thus kept free the wheels would interlock, and the only magnetic field would be the ordinary state of spin about the lines of force, rapidly diminishing in intensity as the distance from the battery or other source of energy is increased. With this space, however, kept free by means of the perfectly conducting wire or smooth rod in the model, there will be an intense magnetic field everywhere immediately in the neighbourhood of the wire and diminishing in intensity as the distance from the wire increases.

All along the wire there will be, in fact, vortex whirls, as shown in Fig. 7, where B is a conductor carrying a current the direction of which is indicated by the arrow. The direction of spin of the positive whirls is shown by the curved arrows. All that is required in order to enable the wire to act in this manner is to have some arrangement capable of exciting vortex whirls about some portion of the wire, which must form a closed circuit, and these vortex whirls will then travel along the wire and produce their effect at the distant stations. These whirls are not found in the wire itself, but in the insulating sheath, so it will be seen that the wire transmits nothing, but only directs the energy on its way by holding apart the mutually opposing wheelwork of the insulator.

In practice the wire is not, of course, a perfect conductor, but the effect of this is merely that the slip on its surface is imperfect. Some of its own wheelwork is therefore set in motion, except along the axis of the wire. Two distinct results follow from this. In the first place, the frictional slip in the imperfect conductor causes a dissipation, into heat, of some of the energy supplied, and therefore only a portion of the initial energy at the sending station is transmitted to the receiving end. In the second place, every time the wheelwork is started, there will be a certain delay, increasing with the diameter of the wire, and which will also be comparatively large if the wheelwork of the conductor is very massive, as would be the case if an iron wire were employed.

THE LAND OF THE BASTIDES.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

AT a time when the authority of a central power was beginning to be felt, and when the free cities were being replaced by *villes royales*, dependent on the King of France, a number of fortified posts sprang up in the wilder country of the south, occupied by "king's men," and essentially military in design. From 1250 to 1350 A.D., these boroughs continued to accumulate, and to this day there are twenty-seven towns in central and southern France that are called simply La Bastide.

The original "bastida" of Provence may have had a high antiquity. It was a fortified farm, like some of those that are still inhabited on the flanks of the Juras, or in the English Pale round Dublin. The positions occupied by several of these strongholds can hardly have been neglected in Gallo-Roman days; but the bastide, as it now appears, dates mainly from the fourteenth century. Far away, you may see the yellow wall, with red-tiled roofs above it, and here and there a round tower at a corner, crowning a spur of the valley-side. Five miles on, you may spy another, and one more, perhaps, across the river, set against the pale hot purple of the sky. The roads occasionally desert the alluvium, and climb from one bastide to the next, passing in at a gate decked with some Palladian ornament, round the town between the ramparts and the houses, and out again into the blaze of sunlight, the permeating sunlight of Provence.

The landscape is a mixture of yellow and grey-green; the hillsides crumble in summer into brown and yellow earth; the quarries of soft stone are yellow; a yellow distemper has even seized upon the houses. The vines, on their posts and Roman trellises, are heavy with grapes, and dull with wind-borne dust; the trees along the road, planted by a benevolent government, have struggled through a joyless youth into a middle age of inutility. The hot air blows from Narbonne and the Mediterranean, and the pink haze hides both the Montagne Noire and the Pyrenees.

In this broad valley, where the head waters of the Gascon rivers almost touch those of the shorter eastern system, we see Fanjeaux, a fortress on the scarp, and Montréal, with its tall Italian campanile, and finally, grey and unbelievable, spreading in the distance like a dark wood along its plateau, the Cité of Carcassonne, roofed and towered as Froissart left it, *par excellence* the great bastide.

XUM

For a picture of mediæval France, with its Roman foundations and feudal superstructure, there is nothing finer than Carcassonne, the old town still cramped within the ramparts, and the *ville basse*, or commercial quarter, lying spread out in the plain below. The narrow streets of the latter, by-the-by, were laid out in the thirteenth century.

Those who in this country could not gain the heights walled themselves securely from attack in the alluvial level. Mirepoix, for instance, is boxed in like a town of the Bavarian plateaux,* and the road now runs round it, rather than enter the tiny gate, and pass, by wooden arcades, beneath the burghers' houses. The fact that, even at Carcassonne, horses are still fed in the grassy interval between the outer and the inner wall, shows how the country folk might find shelter in the *villes royales*, and serves to emphasise the parallel with Bavaria.

But here the essential feature is the enormous width of the valley-floors, not the uniformity of the plateaux. The lowland of the Garonne and its tributaries is 150 kilometres wide from the foothills of the Pyrenees to Marmande; and it is 110 kilometres (more than 68 miles) from Pamiers, through Toulouse, to where the Aveyron leaves the Jurassic plateau in the north. This country, so defined by nature, corresponds almost precisely to the Duchy of Gascony in the time of Charlemagne, a well marked region, with the Pyrenees for its southern march, and meeting Aquitaine along the line of the Ariège and the Garonne. Whoever held the passes of the Pyrenees almost held the heart of France. In the eighth century, the Mohammedan wave, which had submerged Carcassonne, isolated Toulouse, and reached the Atlantic, following the courses of the streams, surged even into the limestone plateaux, and was checked only at Poitiers. It is interesting to note how the central knot of granite, the country of Clermont-Ferrand and the Cevennes, broke the strength of the invasion, which ran up thence on either side, and devastated Autun on the east. Almost in our own time, the British forces, when once the Pyrenees had been rounded, pressed on from one stream to another to the foot of the plateau at Montauban.

This great plain of the Garonne, with the rivers streaming from the Pyrenees, is one of the most striking features of France, when viewed upon an ordinary map. The radial arrangement of the watercourses from the foothills near Bagnères de Bigorre makes the greater part of the country look like one huge delta. Some twenty of these streams are caught by the Adour, and enter the Atlantic at Bayonne; another twenty escape to the Garonne, and so are carried to the north. The lower portions of the two groups thus enclose between them the strange and wind-swept level of the Landes.

The tributaries reaching the north bank of the Garonne are far less neatly grouped, although some have made adventurous journeys from the east. The broad Gascon lowland has, indeed, received the waters from the central plateau, from the great volcanic knot of Aurillac, and from the bare limestone country of the Causses, as well as the rapid drainage of the Pyrenees. In Pliocene times, the elephants already found feeding-room in the Landes, and their remains became entombed in the alluvial clays. The sands of the district have accumulated since then, largely drifted from the Atlantic dunes; and the changes in land-tenure in the present century have led to a destruction of the forests, which alone held the soil together. The State has now been compelled to step in, and to defend the peasantry against themselves by a system of scientific planting. The contrast between this shifting country and the granite frontier of the Pyrenees is abrupt enough when one looks southward; it is a picture in little of the Himalayas and the alluvial plains of India.

Even the yellow rocks which underlie the surface-deposits, and which increase in antiquity as we trace them to the east, are not older than those of our London Basin. But the earliest among them have witnessed the uplifting of the Pyrenees. The marine fossils of the lower Eocene are included in the folds of the foothills at both ends of the chain; the warm sea of southern Europe once stretched across the site of the great ridges. Then the "Alpine" series of earth-movements set in beneath the whole of the European area, and a long east-and-west fold heralded the birth of the Pyrenees. The central mass beyond Bagnères de Bigorre, to this day the "Hautes Pyrénées," formed an island in Middle Eocene times,† and the southern tributaries of the Garonne thus began to flow before the main river was in existence. The relation is the same as that between the Alpine tributaries of the Danube and the Danube itself, which, when it came into being, caught in the smaller streams and systematised them.

The pebbles from the uprising Pyrenees now began to be carried down, and to form beaches and deltas, in which organic remains are rare. The whole floor of the nummulitic sea became a lacustrine region, and the marine beds cease with the close of Eocene times. Mirepoix itself, between the limestone foothills and the antique Montagne Noire, stands upon freshwater strata of the same age as those of Headon Hill in the Isle of Wight. Our southern coast of England, with its marine Eocene and fluviatile Oligocene strata, forms, indeed, an interesting parallel with the land of the Bastides. The vertical and folded chalk of Freshwater Bay represents the compacter Cretaceous limestones that lie along the flanks of the Pyrenees; the period of its uplift has been the same, and on its back we see the gravels worn from it, covering the lacustrine strata to the north, and reproducing the huge stream-deposits which have spread into the plain of Gascony.

The watershed between the Atlantic and the Mediterranean, west of Castelnaudary, is only some 200 metres above the sea. The easternmost tributaries of the Garonne, reaching to Labastide-d'Anjou, have almost touched the head-waters of the steeper Mediterranean streams. This innocent and unnoticed pass has now been traversed by a canal which is fed by the water of both systems. The real features of the landscape are the valley-walls of the Fresquel, running eastward, on a spur of which the bastide of Fanjeaux stands. The parting-ground, however, seems to have been determined as far back as Oligocene times; for the deposits of that period, both east and west of it, are of a freshwater and marshy nature. The submergence that occurred in the Middle Miocene epoch admitted the sea into the plain of Orleans, and far up the long depression that now forms the valley of the Rhône; but the bulge at Castelnaudary held its own, and the Pyrenean earth-movements were still making themselves felt beneath it. By Pliocene times, the whole lowland from Narbonne to Bayonne had been brought above the sea; the desolate Landes had made their appearance, a debating-ground for rivers and the Atlantic; and the

* *See* "Contrasts in Bavaria," KNOWLEDGE, June, 1900.

† *See* De Lapparent, "Traité de Geologie," 4me éd. (1900), p. 1433.

Garonne itself had begun to flow, its course being determined by the eastern and northern margins of the great detrital fan from the Pyrenees.

The rivers on the west of the watershed, in cutting their way down against the rising floor, have exposed nothing older than the marine and lacustrine Miocene deposits, which they are slowly washing away and distributing to form an even plain. The shorter streams on the east, however, notably the Aude, have carved out considerable valleys, and have even cleared their way down to the Cretaceous rocks before they enter the Mediterranean.

The Pyrenees, then, as a whole, are somewhat older than the Alps, and have undergone greater denudation and decay; but their highest elevation was reached in Middle Oligocene times, and marine Eocene strata have been raised 500 metres on their flanks. When we ride, as Froissart did of old, from the plain at Pamiers into Foix, the bold heights that soon close in around us are formed of Cretaceous and Jurassic limestones, squeezed against the knot-like older masses in the chain. The bare crag above Foix itself shows us how these strata have been bent and set on end; and here again, as in the Alps, the work was done, and the mountains were reared, within the limits of the Tertiary era.

In the cold epoch at the opening of Pleistocene times, the Pyrenees were still sufficiently high to feed a local glacier system. The tongues of ice streamed out into the plain, like those from the Alps into Bavaria. The limestone foothills are often found to be scoured and striated, and *roches moutonnées* may be seen, for an example, among the avenues of plane trees below Ax-les-thermes.

The barrier formed by the Pyrenees has naturally been sufficient to affect the human epoch. Just as the land of the bastides was long "Gallo-Roman" in its spirit, looking with suspicion on the Frankish barbarians who held it in their power from the north, so the recesses of the Pyrenees have never become wholly French, and their inhabitants in places speak Catalan, and come down, almost as foreigners, to the markets of Ax or Carcassonne. The passes, being little hindered by snow or avalanches, provide free access into Spain. The women, equally with the men, ride horses, mules, or donkeys, seated sideways upon sacks, after the manner of the mountain-folk; and the farmers come over, serious and straight-mouthed, driving highland cows, and thick-necked bulls, and herds of shaggy goats. The carts are drawn by three or four mules in line, the high collars decorated with scarlet tassels, and green cloths drooping on the animals' backs like veils. Every track is enlivened with the mule-bells and the cracking of whips in the keen air. The atmosphere of Spain itself clings to the mountains, despite the canals and the railways and the northern commerce that have invaded the old Gascon plain.

As a contrast to the geological youth of the Pyrenees, there rises north of the Fresquel and the Aude the old mass of the Montagne Noire.‡ This is one of the relics of an earlier France; it was elevated by successive Palæozoic movements, and formed one of the "Hercynian" ridges, even above the Permian sea. For a comparatively short period it became submerged in Mesozoic times; but the Upper Jurassic epoch saw it established again as a long-backed mountain, looking clear into the Spanish area, across water as yet unbroken by the Pyrenees.

The first folds of the Pyrenees found this obstacle waiting for them. The lacustrine and estuarine Eocene strata, and the Cretaceous limestones below them, were bent up on its southern flank, and now form the curious and bleak plateau, almost a "causse," that we meet as we rise north from Carcassonne. The unchecked wind from the Atlantic, or from the young and giant peaks to southward, sweeps the long slope, and beats on the forests of the crest. The labourers protect themselves, in this open landscape, by building little boxes of stone out in the fields. Wild thyme spreads freely, in default of any richer vegetation, and serves to remind one of the heather on the central plateau. As we ascend, the ravines cut by the streamlets expose ancient Palæozoic strata, Devonian, Silurian, Cambrian, or even the central gneissic core. Above us are gloomy woodlands, among which grey hamlets nestle, poor and isolated, Villardonnel, Cuxac-Cabardès, Labastide-Esparbairenque, names that suggest romance and brigandage in themselves. The summit reaches only 1000 metres above the sea, but the cold of the Grampians may be felt here on the latitude of Florence. The descent from Les Martys to Mazamet is a wild mountain episode, on a road swinging this way and that along the side of a fine V-shaped gorge. At one point a ruined fortress, rising from the torrent, only increases the sense of savagery. As we drop towards the open country in the north, we see as a background the blue highlands of Auvergne, and, far below, the red roofs of industrial Mazamet, a miniature Innsbruck, set on the alluvium of the Thoré.

The Montagne Noire forms an unexpected island in the yellow land of the bastides. It is one of those surprises with which France so frequently awaits the traveller. The railway from Calais to Bâle conveys a very false impression of the country; even the moorlands of Brittany, and the rolling fields of Normandy, are a mere foretaste of the greater France to southward.

‡ *See* especially "Guide géologique en France." *7me Congrès géol. internat.* (1900), "Massif de la Montagne-Noire," by M. J. Bergeron. Also De Lapparent, *op. cit.*, p. 1791, &c.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

In his studies of slow motions Professor C. S. Slichter, by means of kinetoscope pictures, has so magnified the motions that the growth of seedling peas and beans during three weeks is shown in a few seconds. The plants were photographed on the kinetoscope film by artificial light at intervals of a few minutes to a few hours during the three weeks. On projecting the pictures upon the screen at the usual rate, the motion of growth was magnified about 500,000 times, and the different rates of development of the various parts were brought out very clearly. Among the striking results was the curious behaviour of a pea struggling to enter impenetrable soil, the root curving and writhing much like an angle worm, while the pea was rolled about very grotesquely.

Mr. C. Reichert, of Vienna, makes a new form of apparatus which may be used either for photomicrography, drawing, or projection. It consists of a stand, fitted with a stage capable of moving up and down, to which may be adapted either a photographic camera or a projection apparatus. It is intended principally for low power work, five to thirty diameters, and can be used either with petroleum, spirit, or gas.

A suitable ray film for photographing bacteria and other objects which have been stained with fuchsine, methyl blue, or gentian violet is prepared by dissolving 160 grammes of pure nitrate of copper and 14 grammes pure chromic acid in 250 c.c. of water. This solution permits light rays of wave length of from 570 to 550 to pass, and causes the objects stained with the above mentioned solutions to appear black on a green ground.

Experiments by E. Klein indicate that, contrary to common belief, such germs as those of cholera, typus, and diphtheria do not survive more than three or four weeks after burial in the ground.

Messrs. R. & J. Beck, of Cornhill, London, have recently put upon the market several new pieces of apparatus the most important

of which are a Wide Angle Immersion Condenser with an aperture of 1.4 N.A., an aplanatic cone of 1.3 N.A., and a working distance of .06 of an inch. They have also introduced a new, cheap one-tenth immersion objective, with an aperture of 1. N.A.

The copper amalgam, known as Viennese metal cement, is well adapted for modelling the most delicate objects, and it is therefore of special value to the histological microscopist. The method of preparation is as follows: Copper is precipitated as a very fine powder from a solution of blue vitriol by means of strips of zinc, and after being washed and treated with a solution of mercurous nitrate, hot water is poured over the copper in a mortar, and the mercury, in the proportion of seven parts to three of copper, is added. The resulting amalgam becomes so soft under water that it can be used for modelling the most delicate objects from plaster casts. It hardens into a malleable mass that can be polished like gold and is not readily tarnished except by hydrogen sulphide, and it is a strong cement for metals. When impressions have been made on thin sheets the amalgam may be reinforced by pouring on molten type metal.

The Bausch and Lomb Optical Company has just issued a revised edition of a useful little manual entitled "Manipulation of the Microscope."

Corks that have been steeped in vaseline are an excellent substitute for glass stoppers without their disadvantages. They are not affected by acids or chemical fumes, and they do not become fixed by a blow or by long disuse.

The following process for preparing delicate specimens of hymenoptera for mounting is strongly recommended. The insects are placed in a wide-mouthed bottle containing an acid mixture made up of one ounce of pure, dry crystals of carbolic acid dissolved in four ounces of oil of turpentine, and are left to soak in this for a couple of days. A specimen is then taken out and arranged on a glass slip. A cover glass is placed over it, and sufficient pressure applied to flatten out the thorax. It is then placed between clips and allowed to stand in the acid solution for a day or two longer, after which it is carefully washed in filtered oil of turpentine, again placed between the clips and soaked in the turpentine for two or three days. This hardens the insect so that it can be easily handled without breaking. It is now ready to be mounted in moderately thin balsam.

The classification of fresh-water sponges is based upon the form and character of the spicules. As these are invisible to the naked eye, and are difficult to obtain without special preparation, the following method of development will be of interest to the student and to the collector alike. The spicules are embedded in the sarcode or flesh of the sponge, and the object of the processes of preparation is to effectually remove this organic matter. To do this place a fragment of the sponge skeleton and a few gemmules in a watch glass and apply a drop of nitric acid. Boil, and repeat the process until the sarcode and gemmule contents have disappeared. Thoroughly wash with distilled water, and stand on one side to allow of the spicules separating out.

Mons. B. Renault holds bacteria to have been a most powerful factor in the world's geological development. He believes that they transformed wood into coal, and that several species of the fossilized bacteria have been discovered in coal by himself and Professor C. E. Bertrand.

Formaldehyde is well known to the microscopist as an inexpensive and effective fixing agent. As a rule it is seldom used in solution stronger than ten per cent, and then generally in conjunction with mercuric chloride. The following formula has yielded very satisfactory results for normal tissues, the material being killed and fixed in the solution in from six to twelve hours. Formaldehyde 40 per cent. solution, 50 c.c.; distilled water, 50 c.c.; glacial acetic acid, 5 c.c. After fixing the tissues are transferred to three grades of alcohol, viz., 50 per cent., 75 per cent., and 95 per cent. respectively, and mounted in paraffine. Care should be taken to perform the operation of dehydration thoroughly, otherwise the sections will drop out of the embedding matrix when being cut. The tissue may be run back through xylol into absolute alcohol, and left until every trace of water is removed. If the specimen appears milky or opaque in the clearing fluid it is not ready for embedding, but needs to be left in alcohol for a longer time until dehydration is complete.

Beginners in microscopy frequently overlook the fact that it is possible to have the field of view too brilliantly illuminated. With ordinary powers it is necessary, in order to secure good definition of the finer details of the object, to moderate the brilliancy of the light either by the use of the diaphragm attached to the sub-stage or by moving the source of illumination further away. The result of a too brilliantly illuminated field of view is to "drown out" the details and render the image flat, and therefore a clear, small light is often a positive advantage.

Molluscan nerve tissues require careful treatment in the preliminary stages of preparation to ensure satisfactory mounts. An effective macerating fluid for this purpose is prepared as follows: — Acetic acid, 5 parts; glycerine, 5 parts; distilled water, 20 parts. After soaking the specimens in this for from four to twenty-four hours they are teased in fifty per cent. glycerine, or washed and stained in picro-carmine or ammonia-carmine.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

GIACOBINI'S COMET.—This object is now rapidly becoming fainter, with increasing distance from the earth. It will not be observable during the second week of August owing to moonlight, but a powerful telescope will reveal the object in the position assigned by Berberich in the following ephemeris (Ast. Nach. 3636):—

Date.	R.A. h. m. s.	Declination. ° ′	Distance in Millions of Miles.
August 3 ...	19 22 21 ...	39 51 N. ...	113
„ 7 ...	18 57 55 ...	36 39 N. ...	117
„ 15 ...	18 21 18 ...	30 7 N. ...	130
„ 19 ...	18 8 0 ...	27 1 N. ...	137
„ 23 ...	17 57 19 ...	24 9 N. ...	146
„ 27 ...	17 48 46 ...	21 30 N. ...	156
„ 31 ...	17 41 57 ...	19 5 N. ...	164

Thus the comet's motion carries it rapidly through Lyra and Hercules. After August it will be an exceedingly faint object, and only visible in very large instruments.

RECENT COMETARY DISCOVERIES.—Very few new comets appear to have visited our parts of space during the last 15 months, judging from the number of discoveries, for only two have been found, and in both cases the first observer was M. Giacobini, of Nice. It is true that several periodical comets have returned during the period named, but on the whole comet seekers have met with very little success. It is, however, highly probable that we shall shortly hear of a discovery in this field, for the months of July and August have been the most prolific hitherto in furnishing us with new comets.

FIREBALL OF SUNDAY, JUNE 10.—A large fireball was seen in the twilight by several observers at widely distant stations. Lieut.-Col. Boileau, M.D., A.M.S., of Trowbridge, gave the time as about 9h. 10m., and described the meteor as passing about 15 degrees above Venus from N.E. to W. at an angle of about 30 degrees. Twilight was so strong that there was nothing visible in the heavens except the moon, Venus, and Jupiter. At Spilsby, Lincoln, the meteor was seen by Mr. J. Richardson, who says he first noticed it about 60 degrees above the horizon like a shooting star to the W.S.W. "After falling a few degrees at an angle of 75 degrees towards the S.W. it became very bright, and continued so for about 30 degrees more, when it seemed to break into several fragments and lose its light, finally diappearing rather suddenly about 10 degrees above the horizon. It was 2 seconds in falling, and appeared considerably more than double the diameter of Jupiter." The Rev. F. B. Allison, of Peasmarsh, gives the time as 9h. 12m., and says the first appearance was at some 10 degrees altitude. The meteor then appeared to traverse a meridian (8h. 30m about) and occupied 1½ seconds in passing over 10 degrees to a low cloud on the horizon behind which it disappeared. The brightness of the head was 1½ times that of Venus. The meteor left a short flaming tail of intense green colour, after which came a trail of sparks of several degrees in length; the meteor was slow. At Colwyn Bay Mr. W. B. Russell noticed it falling in the southern sky at 9h. 15m. p.m. The meteor was more than double the diameter of Jupiter, and it fell perpendicularly downwards, leaving a most brilliant copper green trail. Its course was very short. A friend who was with Mr. Russell thought the colour at first blue and green, and the nucleus of the meteor seemed to break into two fragments. Mr. A. Mee, of Cardiff, saw the meteor in the west about one-third of the way from the horizon to the zenith, but no further particulars are given as to the direction of flight or velocity.

Comparing the various accounts it appears highly probable that the meteor was a Cepheid, and from a radiant either at 336 + 73 or 310 + 77. The heights were from about 65 miles over Lampeter to 28 miles over a point near Worm Head, Gower, S. Wales, but these results are approximate, and more observations are required before the meteor's exact path in the air can be determined.

LARGE METEORS.—Mr. A. King, of Leicester, reports that on June 24, at 10h. 57½m., he saw a fine meteor of a beautiful yellow hue and brighter than Venus at maximum. The first part of the flight was not well seen, as the observer was not facing the object, but the latter part of the course was from 213° + 44½° to 203° + 22°,

which it completed in 2½ seconds. The direction seemed slightly curved to N.W. The nucleus was stellar, and it left a short train. On Sunday, July 15th, 10h. 13m., a very brilliant meteor was seen at Bristol, Leeds, and Melthan, near Huddersfield. It exceeded Venus in lustre and was directed from a radiant at 297°—11°. It fell from a height of 51 to 21 miles from over Warrington to Ravenglass, on the coast of Cumberland. Length of observed path 78 miles, and velocity 16 miles per second.

August Perseids.—The moon being full on August 10 the splendour of this year's display will no doubt be greatly moderated. Notwithstanding moonlight, however, the shower may be expected to be sufficiently strong to enable its radiant to be determined on every fine night during the first 13 nights of the month. During the opening week of August the moon will not offer a serious impediment, and the shower may be watched to advantage in the morning hours. The exact place of the radiant on each of the first few nights of the month would be valuable, as very few determinations have ever been made at this early period of the shower's manifestation.

August Draconids.—Between August 21 and 25 a well defined and rich shower of Draconids, observed at Bristol in 1879, should be looked for. It is probably of periodical character, and does not appear to have been re-observed since the year referred to. The radiant is at 291° + 60°, near the small star ο Draconis, and the meteors are bright and move slowly. In addition to these Draconids there are a large number of interesting showers visible during the last ten nights of August.

THE FACE OF THE SKY FOR AUGUST.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 4.24 and sets at 7.48; on the 31st he rises at 5.12 and sets at 6.48. Conspicuous sun spots are not to be expected, but small ones may occasionally be seen.

The Moon.—The moon will enter first quarter on the 3rd at 4.46 P.M.; will be full on the 10th at 9.30 P.M; will enter last quarter on the 17th at 11.46 A.M.; and will be new on the 25th at 3.53 A.M. The brightest star occulted during the month is Iota Tauri, mag. 4.7; the disappearance takes place at 0.42 on the morning of the 19th, at an angle of 41° from the north point (81° from the vertex), and the reappearance at 1.24 A.M., at an angle of 304° from the north point (346° from the vertex).

The Planets.—Mercury is a morning star in Cancer, well placed for observation for a few days before and after the 20th, when he reaches greatest western elongation of 18° 32′. On the 15th he rises an hour and a half before the sun, on the 20th an hour and three-quarters before the sun, and on the 25th an hour and forty minutes before the sun.

Venus is a morning star, at greatest brilliancy on the 14th, nearly three-tenths of the disc being then illuminated. The path of the planet is easterly, from near Gamma Geminorum on the 1st to near 68 Geminorum on the 31st. The apparent diameter of the planet diminishes from 45″.6 to 29″.2 during the month. At the beginning of the month the planet rises shortly after 2 A.M., and at the end a little before 1.30 A.M.

Mars rises between midnight and 1 A.M. during the month. He is in the constellation Taurus (near Zeta on the 1st) until the 8th, when he passes into Gemini. The distance of the planet is so great, however, that the disc only subtends an angle of 4″.6 to 5″.0. At the middle of the month a little more than nine-tenths of the disc is illuminated.

Jupiter may still be observed for a short time in the evening; setting about 11.30 P.M. on the 1st and about 9.40 P.M. on the 31st. He is in the constellation Scorpio, his path being a short easterly one a little south of Beta Scorpii. On the 25th the planet is in quadrature with the sun. The satellite phenomena are most interesting—on the 3rd (9.59), 4th (8.48), 11th (9.6), 12th (8.34), 19th (8.14), 20th (8.56), and 29th (8.33).

Saturn may be observed up to about midnight through the first half of the month. The path of the planet is a very short westerly one in the western part of Sagittarius. On the 18th the apparent polar diameter of the planet is 16″.2, and the outer major and minor axes of the outer ring 40″.7 and 18″.4 respectively, the northern surface being visible.

Uranus remains in Ophiuchus, near to the star Omega in that constellation, a few degrees to the east of Jupiter; and may be observed only during the early evening. The planet is stationary on the 17th.

Neptune does not rise until after midnight during the greater part of the month. He is in the most easterly part of Taurus, one and a half degrees south of Mars on the 7th.

The Stars.—About 10 P.M. at the beginning of the month, Perseus and Cassiopeia will be in the north-east; Pegasus, Andromeda, Aries and Pisces towards the east; Aquarius and Capricornus in the south-east; Cygnus and Lyra nearly overhead; Aquila due south; Hercules and Ophiuchus towards the south-west; Corona and Boötis in the west; and Ursa Major in the north-west.

Minima of Algol will occur on the 4th at 11.55, on the 7th at 8.43, and on the 27th at 10.26.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of July Problems.

No. 1.

(B. G. Laws.)

Key-move—1. Kt to B6.

If 1 . . . R × P, 2. B to K4ch, etc.
1 . . . B × RP, 2. Q to K4ch, etc.
1 . . . R to Kt3, 2. Q × Pch, etc.
1 . . . Kt to B2, 2. P to Kt4ch, etc.
1 . . . K moves etc. 2. B to R5 etc.

No. 2.

(W. H. Gundry.)

Key-move—1. Kt to Q4.

If 1 . . . K × Kt, 2. Q to Q6, etc.
1 . . . P to R5, 2. Q to B2ch, etc.
1 . . . K to Kt5, 2. Q to Q6ch, etc.
1 . . . Kt moves, 2. Q to QB6ch, etc.

Correct Solutions of both the above received from H. Le Jeune, H. S. Brandreth, G. A. Forde (Capt.), G. W. M., W. de P. Crousaz, J. Baddeley.

Of No. 1 only from K. W.
Of No. 2 only from Alpha.

Mr. Macmeikan's sui-mate is solved as follows:—

1. B to QR2, P moves.
2. R to K6, P moves.
3. B to B6, P moves.
4. R to K3, P moves.
5. Kt (Q3) to K5ch, R to Q6.
6. B × P, R × R.
7. B to Ksqch, R × B mate.

ALPHA.—You will see that your inspiration as to the key of No. 1 was correct, though not completely followed out in the main variation.

A. B. WATSON.—I have not the problem by me, but think you will find it all right.

W. PARKINSON.—After 1. P × B (Q) ch, R × Q; 2. Q to K7, K to Kt3; 3. Kt to K5ch is not mate.

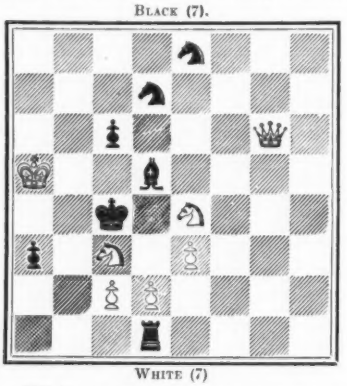
G. W. M.—I regret that I cannot decipher your signature, so have given initials only. You will see that your first move only in the sui-mate is correct.

PROBLEMS.

No. 1.

From the *Manchester Weekly Times.*

BLACK (7).



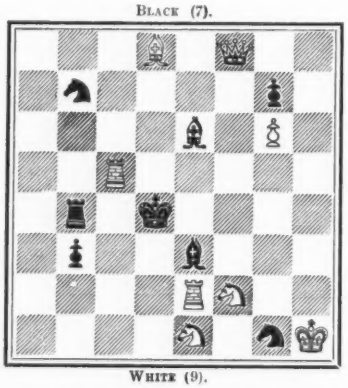
WHITE (7)

White mates in two moves.

No. 2.

By A. F. Mackenzie (Jamaica).

BLACK (7).



WHITE (9).

White mates in three moves.

"A Memorial of the City of London Chess Tournament" (Longmans, Green & Co.). It is not often that a book on chess, or any other game, is so artistically got up as this record of the recent invitation tournament for masters and amateurs, which was held at the City of London Chess Club in April and May, 1900. The volume contains the whole of the 78 games played in the tournament, together with the original programme of play, the score-sheet and an index of the openings. Another instructive table gives the relative successes of the different openings played: the success attending the Sicilian defence is especially noteworthy, as is the failure of the French defence. There is evidently nothing much in the Ruy Lopez, but the Queen's Gambit declined comes out badly for the defence. The book is published at 2s., and may be obtained from Mr. J. W. Russell, Hon. Sec., City of London Chess Club, 7, Grocers' Hall Court, E.C., for 1s. 6d. (1s. 8d. post free), or seven copies will be sent post free for 10s.

CHESS INTELLIGENCE.

Brighton Society announces its twelfth Problem Tournament for direct mates and sui-mates in two moves. Three problems may be sent in for each section, and there will be three prizes in both classes. Competing problems must reach the Chess Editor, 93, Richmond Road, Dalston, N.E., by December 1; or from abroad by January 1, 1901.

The following is the result of the Paris International Tourney:—

E. Lasker, 14½, 1st prize £200 and Sevres Vase.

H. W. Pillsbury, 12½, 2nd prize £100 and Sevres Vase.

F. Marshall, 12, 3rd and 4th prizes £80 and £60 divided and Sevres Vase.

G. Maroczy 12, 3rd and 4th prizes £80 and £60 divided and Sevres Vase.

A. Burn, 11, 5th prize £60.

M. J. Tchigorin, 10½, 6th prize £40.

G. Marco, 10, 7th and 8th prizes £16 and £8 divided.

J. Mieses, 10, 7th and 8th prizes £16 and £8 divided.

C. Schlechter, 10; D. Janowski, 9; J. W. Showalter, 9; J. Mason, 4½; N. Brody, 4; Rosen, 3; J. Mortimer, 2; M. Sterling, 1; and Didier, 1.

The prizes of £20 and £12, presented by Baron Albert de Rothschild, of Vienna, for the best games played during the tournament, have been awarded to Mieses for his game against Janowski, and to Tchigorin for his game against Mortimer.

Mr. Lasker's score of 14½ out of a possible 16 is one of the best on record, and will, if possible, enhance his reputation. He lost only to Mr. Marshall, and drew with M. Tchigorin only when already certain of the first prize. Of the rest, Messrs. Pillsbury, Maroczy, Burn, Tchigorin, Marco, and Mieses came out in or near the places which might have been predicted for them, but Herr Schlechter and M. Janowski are accustomed to higher flights. The latter's performance is especially disappointing as he made an excellent start. The immense gap between Mr. Showalter and the last six players is most noticeable. It is most disappointing to find Mr. Mason in this latter category; better things were also expected of Herr Brody.

Many of the competitors will take part in the Munich Chess Congress which begins on the 21st of July. This will be limited to eighteen competitors without regard to nationality, and may be nearly equal in quality to the Paris tournament.

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